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COMMON AGENT OR DOUBLE AGENT? PHARMACY BENEFIT MANAGERS IN THE PRESCRIPTION DRUG MARKET

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A data appendix is available at http://www.nber.org/data-appendix/w28866

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Abstract

In the U.S., pharmacy benefit managers (PBMs) manage prescription drug purchases for payers. Firms selling branded pharmaceuticals bid for preferred slots on the PBM's formulary by offering rebates off of list price. We find that PBMs enhance efficiency, but the gains do not accrue to consumers or drug makers. Our analysis offers insights into otherwise puzzling questions. Why do drug makers pay rebates to PBMs? Why do payers delegate formulary operation to a few large PBMs? Why are list prices so high? Why might PBMs vertically integrate with payers? Our framework also offers insights into proposals for market reform.

1 Introduction

Every national healthcare system relies on a set of policies and institutions to balance the tricky tradeoff between innovation incentives and access to new, innovative drugs (Scherer, 2000).[1] The U.S. system relies on a peculiar a set of organizations called

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[1]The U.S. healthcare market also faces well known principal-agent challenges: physicians act as agents for patients in their demand for medical care and health insurance plans act as payers for medical services provided by physicians and other medical providers to patients (McGuire, 2000; Pauly, 2000).

pharmacy benefit managers (PBMs).

PBMs are for-profit, non-governmental companies that manage pharmacy benefits on behalf of health plans and other payers. Virtually every commercial health insurance plan in the U.S. uses a PBM. Medicare, the government insurance program for the elderly and disabled, also relies on PBM services to manage drugs purchased under Medicare Part D drug plans and Medicare Advantage plans. Many states also use PBMs in their Medicaid prescription drug programs covering vulnerable individuals including children, pregnant women and the poor (Kaiser Family Foundation, 2020; Yost, 2018; Royce et al., 2019).

PBMs play a central role in drug markets and they are a focus of increasing scrutiny from policymakers, but little attention has been devoted to analyzing the economics of these organizations. This is in part due to the opaque contracts governing PBMs' relationships with payers on one side and drug makers on the other.[2] In this paper, we offer a microeconomic analysis of the role of PBMs in the U.S. market for on-patent prescription drugs, also known in the industry as branded drugs. While non-patented "generic" drugs make up the bulk of prescriptions sold in the U.S., branded drugs account for nearly three quarters of total drug spending (IQVIA Institute for Human Data Science, 2018).

To manage drug spending, PBMs make use of a formulary. A formulary is a list of covered drugs with associated prices for consumers and plans. It is common for formularies to feature different "tiers" of drug coverage. In their role as formulary operators, PBMs allocate drugs to the different formulary tiers. A branded drug assigned to a preferred tier will enjoy lower copays (the portion of the price paid by the consumer) and hence higher demand.[3]

[2]Parties treat these contracts as trade secrets and US regulators generally agree with this perspective. What little is known of the workings of PBMs comes largely from their own public shareholder reports, court fillings, and documents revealed through government hearings and investigations.

[3]Generally, PBMs allocate generic drugs to the most preferred tier. PBMs do more than structure competition between the makers of branded drugs. They also develop generic substitution policies, prior authorization programs, and disease management services. PBMs also strike agreements with pharmacies over the amount and timing of professional fees for dispensing drugs (Feldman, 2020). We do not include these auxiliary functions in our theoretical model of PBMs.

Branded drug makers compete for preferred formulary placement for their drug by offering PBMs rebates off the drug's list price. Rebates are quite controversial and raise pointed questions. Are they a kind of side-payment that undermines PBM incentives to negotiate drug prices aggressively on behalf of their clients? If so, then why do payers rely on such potentially compromised representatives? If not, why do branded drug makers pay the rebates at all? Would consumers be better served if rebates were prohibited altogether or, alternatively, directly handed over to health plans or to consumers themselves?

Other questions result from the enormous size of PBMs and the high degree of concentration in the industry. In 2018, three PBMs (Express Scripts, CVS Health/Caremark, and OptumRX) accounted for 80 percent of prescription drug volume and six PBMs account for 95 percent of the prescription drug market (Fein, 2019; Feldman, 2020). The CVS-Health/Caremark PBM alone reports nearly 90 million members in its PBM business—and so negotiates on behalf of a customer population larger than the population of Germany (CVS Health, 2017). Do such large PBMs in a highly concentrated industry obtain lower drug prices on behalf of payers and consumers, or do they leverage their monopsony position to gain at the expense of consumers, health plans and branded drug makers?

Our analysis model builds on three observations about the operation of PBMs. The first concerns the incentives that formularies implicitly provide to drug makers. Formularies assign branded drugs to tiers. If a branded drug is assigned to a preferred tier, enrollees in the formulary pay little or nothing for the drug. Enrollees using drugs assigned to a less preferred tier pay more. Thus branded drug makers who win a spot in a favored tier gain a boost in sales. Drug makers compete for a preferred spot on the formulary by offering per-unit rebates off the drug's list price. From this perspective, tiered formularies have the same incentive structure as all-pay contests: the per-unit rebates constitute the "bid," and the prize for winning the contest is a favored position in the formulary.

Our second observation is that PBMs are market intermediaries who have to offer value to both upstream branded drug manufacturers and downstream health plans. Branded drug makers will participate in formularies if doing so is at least as

profitable as the alternative of selling at list price. Payers will, similarly, seek out formulary services to the extent that the formulary offers net prices below list. Any account of PBMs as market intermediaries must also explain why payers delegate formulary operation to large PBMs who act as a common agent for many payers.

Our third observation concerns the high list prices of branded drugs sold on formularies administered by PBMs.[4] In a drug market without rebates, list prices are transaction prices. With rebates, however, few transactions may take place at list price. In an extension to our baseline model, we find that high list prices matter for overall market efficiency and consumer welfare even if very few transactions take place at list price.[5]

The theoretical framework we use is stylized and abstract, but it nevertheless helps us understand formulary incentives, the PBM's role as intermediary, and the importance of high list prices. As a result of their incentive structure, formularies improve efficiency relative to the alternative of selling branded drugs at their monopoly prices. The surplus generated by these efficiency-improving contests could, in principle, enhance consumer welfare, or make more resources available to drug makers for innovation but instead they accrue as rents to PBMs. On this basis, the challenges PBMs pose for economic policy have more to do with distribution than static efficiency.

The framework also offers insights into why a health plan would delegate the formulary function to large PBMs who act as a common agent for many commercial and government payers. In an extension to our baseline model, we find efficiency gains when all the payers delegate the formulary operation to a single, large, PBM. These efficiency gains are not the result of technological economies of scale or scope. Neither do they rely on any relationship between bargaining power and the size of the

[4] IQVIA Institute for Human Data Science (2020), for example, documents a growing disconnect between the list prices for branded drugs and their net price accounting for rebates.

[5] The term list price often refers to the Average Wholesale Price (AWP). A joke in the industry refers to AWP as "Ain't What's Paid," underscoring the divergence between list and transaction prices. As an empirical matter, previous studies suggest a significant number of insured Americans pay list price for at least some of their drugs because their health plan provides incomplete coverage. In addition, individuals who are uninsured for prescription drugs also pay list prices (Augustine et al., 2018).

intermediary. Rather efficiency increases because a large PBM can better internalize externalities resulting from the widespread use of most favored nation provisions that promise purchasers the highest rebates (or equivalently the lowest net drug price) offered anywhere in the market.

The analysis also clarifies the economic significance of list prices in the market for branded prescription drugs. The central insight is that rebates are available only for drugs sold on the formulary. Otherwise, branded drugs sell at their list price. Thus, when a branded drug maker sets a high list price for their drug they are, all else equal, increasing the value to consumers of purchasing the drug on the formulary at a discount. If participating in the formulary becomes more valuable, the PBM can extract more value from consumers than would be possible with lower list prices. In an extension to our baseline model we find that in equilibrium, some branded drug makers will set list prices very far above monopoly prices, and PBMs will bias their formulary contest to favor such high list price branded drugs. Biased formularies make the pharmaceutical market less efficient and consumers less well off, while increasing the surplus accruing to PBMs and branded drug makers.

Finally our analysis of PBMs as a common agent for many payers sheds some light on the benefits of vertical integration. In the past several years, large PBMs have vertically consolidated with health insurers, including UnitedHealth Plans (health plan) with OptumRx (PBM), Aetna (health plan) with CVS Caremark (PBM), and Blue Cross Blue Shield plans (health plan) with PrimeTherapeutics (PBM). Vertical integration can enhance efficiency or it can be anti-competitive. Understanding which outcome prevails requires an institutionally informed applied theoretical model (Gaynor, 2006). In the case of mergers between an agent (the PBM) and its principal (the payer), the central theoretical issue is what problems a merger solves that are not solved by a contract between the parties. In a setting where a PBM captures the joint surplus produced by itself and a payer, there is little economic reason to vertically integrate because there is an easy alignment of interests between principal and agent as separate entities. In a richer setting, a payer may want to induce the PBM to take actions that may benefit the payer but not the PBM. A payer may, for example, wish to promote the use of low price generic drugs that offer no rebates

to PBMs. In a conventional principal-agent relationship, both parties would realize benefits from enhanced generic use and there would also be little reason to vertically integrate. Common agency, in contrast, can severely limit the use and effectiveness of such contracts. In this setting, vertical integration between a PBM and payers may benefit both parties without making the market less competitive.

We are not the first to observe that auction-like competition can help make markets for patented innovations more efficient. Kremer (1998), for example, proposes that governments offer to purchase patents at their estimated private value as determined by an auction. Selling these products to consumers at a price equal to marginal cost would eliminate monopoly price distortions while still providing innovation incentives. Formularies in our model similarly reduce monopoly price distortions to the extent that they offer copays for drugs that approximate marginal cost. Contrary to Kremer's analysis, however, the bidding for preferred formulary slots aims to generate large rebates rather than to elicit the branded drug maker's private information about the value of their product. Formularies more closely resemble the all-pay contests analyzed in Siegel (2009) in which players make irreversible bids before the outcome of the competition is known.

Our primary theoretical contribution to the literature on contests is that we derive the equilibrium structure of prizes and rules for selecting winners when the contest is operated by a market intermediary. Creating value for both upstream and downstream players shapes equilibrium contest design for market intermediaries in ways that have not been previously studied. So too does the contracting externality that causes payers to delegate formulary operations to a single large PBM who acts as a common agent for many payers.[6] We are not aware of any other formal models of contest design by market intermediaries.

The paper proceeds in four sections. In the next section we describe what is known of the PBM business model. Section 3 sets up our analytical framework. In Section 4, we present the baseline model in which a single third party payer designs

[6]For a general analysis of contracting externalities see Segal (1999). For prior analyses of common agency in other aspects of healthcare see Frandsen et al. (2019); Glazer and McGuire (2002); Einav et al. (2020). The foundational analysis of the general theory of common agency is Bernheim and Whinston (1986).

the formulary and drug makers choose rebates for their branded drugs. In Section 5, we extend the base model to allow for varying degrees of substitutability between drugs and varying number of branded drugs. In Section 6, we extend the model to allow for multiple payers and contracting externalities. Section 7 modifies the baseline model by allowing branded drug makers to endogenously determine both rebates and list prices. Section 8 discusses how vertical integration results from common agency. We conclude by discussing some broad policy implications of our results as well as directions for further research.

2 Institutional Setting: The PBM Business Model

PBMs are intermediaries between drug makers and payers, and operate formularies for their clients, health plans, and other payers. Figure 1 depicts the PBM' s business model. For clarity this depiction is highly stylized and it omits a number of features of real-world markets. The US prescription drug market is complex and entails multiple parties including drug makers, health plans, consumers, pharmacies, wholesale distributors and PBMs. In our depiction of the PBM's business model, we ignore the role played by large wholesale drug distributors such as McKesson. Similarly, we omit the interactions between PBMs and pharmacies.

Branded drug manufacturers sell drugs to PBMs at a posted unit list price but then provide a rebate for each purchase.[7] The list price minus the per unit rebate—what we call the net price—is the effective wholesale price that the PBM pays for each drug sale. When enrollees purchase a branded drug from the PBM, they pay a copay and also perhaps some coinsurance rate which is not presented in the Figure. The PBM bills the insurer the reimbursement price for the drug minus the amount that the enrollee already paid. In addition to copays, enrollees also pay insurance premiums and the coverage they receive entitles them to participate in the formulary and enjoy the drug subsidies that accompany insurance.

The contracts between health plans and PBMs are closely held trade secrets. We

[7]Market participants will sometimes refer to the list price as the Average Wholesale Price (AWP) or alternatively the Wholesale Acquisition Cost (WAC).

learned about these contracts from a sample of contracts that we could examine directly, from the release of three government reports on PBM business practices (Grassley and Wyden, 2021; Government Accountability Office, 2019; Yost, 2018), and from some other reports (Feldman, 2019; Ciaccia, 2020). In the contracts and other reports we examined, drugs are assigned to different formulary tiers and the PBM commits to delivering these drugs to the payer at a discount off of the drug's unit list prices. A contract might, for example, commit the PBM to provide all branded drugs in the formulary to the payer at an average reimbursement price that is 11 percent below AWP. Suppose that the PBM's net price for branded drugs averaged 30 percent below list; then the PBM earns a profit equal to 19 percent of the list price on each unit of a branded drug sold. Generics were supplied at prices even further below their unit list price on average—in the neighborhood of 50 percent below list.[8]

In the industry, the difference between the reimbursement price of the drug and the net price at which the PBM acquires the drug is called the spread. The spread on branded drugs is generally presumed to be an important source of PBM profits. Industry reports estimate that the total value of manufacturers' gross-to-net reductions for brand name drugs was $175 billion in 2019—of which about two-thirds comes from rebates (Fein, 2020).[9]

Finally, the U.S. prescription drug industry features most favored nation rules (MFNs). MFNs are provisions that guarantee purchasers the lowest net price offered to any purchasers of the drug. MFNs matter for our model because, as we discuss below, they create a contracting externality that ends up favoring the emergence of large PBMs acting as common agents for multiple payers.

[8]Many contracts also contain commitments to dispense the majority of drugs as generics rather than brands. These contract features are called "generic effective rates" and are calculated in aggregate across all dispensed drugs. The contracts we examined also included per member fees and transaction charges to payers for the handling of drugs. These charges differ depending on whether the drug order was filled by mail order, in house, or other pharmacies. Fees can be paid per unit of drug sold or in aggregate. Industry reports suggest these fees may be a growing source of revenues for PBMs. (Feldman, 2020; Fein, 2017). We do not include these fees in our analysis.

[9]PBMs can also make money on a variety of fees which are not set to reflect any specific drug's list price or sales volume.

There are two types of MFNs in the market for prescription drugs. The first are contractual provisions between drug makers and PBMs. While the contracts between drug makers and PBMs are closely guarded trade secrets, details are sometimes made available in litigation—often in contractual disputes between PBMs and drug makers when "best price" is at issue. We learned from discussions with lawyers and economists who have been intimately involved in such litigation, that MFN clauses are common. Specifically, the contracts between PBMs and drug makers will state that the PBM is entitled to rebate amounts that reflect the contracts drug makers make with their peers.[10] These arrangements are also described in Feldman and Frondorf (2017) and Feldman (2019).

The second type of MFN is the result of administrative pricing rules guaranteeing certain safety net providers the lowest net price prevailing in the market. The most important of these is the Medicaid Prescription Drug Rebate Program (MDRP) (Scott Morton, 1996; Congressional Budget Office, 2005).[11] The Medicaid rebate amount is set in statute and ensures that the program gets the lowest net price (with some exceptions).[12] State Medicaid programs provide coverage for prescription

[10]These clauses tend to be included in the first contract with the drug maker, but may not be mentioned in the contract renewals or "amendments."

[11]In 1990 the Federal Government included a Most Favored Customer (MFC) clause in the contract (OBRA 90) which would govern the prices paid to firms for pharmaceutical products supplied to Medicaid recipients. Under the program, a drug maker who wants its drug covered under Medicaid must enter into a rebate agreement with the Secretary of Health and Human Services stating that it will rebate a specified portion of the Medicaid payment for the drug to the states, who in turn share the rebates with the federal government. In exchange, Medicaid programs cover nearly all of the drug maker's FDA-approved drugs, and the drugs are eligible for federal matching funds. Though the pharmacy benefit is a state option, all states cover it, but, within federal guidelines about pricing and rebates, administer pharmacy benefits in somewhat different ways. Drug makers must also enter into agreements with other federal programs that serve vulnerable populations.

[12]The formula for rebates varies by type of drug: brand or generic. The rebate formula is the same regardless of whether states pay for drugs on a fee-for-service basis or through payments to managed care plans. For brand name drugs, the rebate is 23.1 percent of average manufacturer price (AMP) or the difference between AMP and "best price," whichever is greater. Certain pediatric and clotting drugs have a lower rebate amount of 17.1 percent. Best price is defined as the lowest available price to any wholesaler, retailer, or provider, excluding certain government programs, such as the health program for veterans. AMP is defined as the average price paid to drug makers by wholesalers and retail pharmacies. For generic drugs, the rebate amount is 13 percent of AMP, and there is no best price provision. Drug makers must report AMP for all covered outpatient drugs to

drugs for those who qualify. As of August 2020, the Medicaid program enrolled over 75 million individuals—roughly one in five Americans (Centers for Medicare and Medicaid Services, 2020).[13] A recent Congressional investigation found evidence that drug makers took MDRP's MFN provisions into account when setting prices. "Internal memoranda and correspondence collected for this investigation suggest that manufacturers seek to avoid triggering Medicaid 'best price' when developing their bids for commercial plans (Grassley and Wyden, 2021, p.68)."[14]

Medicaid's MDRP is the basis of at least one other most favored nation rule governing prescription drugs, 340B drug discounts (Conti et al., 2019). As a condition of participation in the Medicaid Drug Rebate program, drug makers must also participate in the Federal 340B program. The 340B program offers discounted drugs to certain safety net providers that serve vulnerable or underserved populations, including Medicaid beneficiaries. 340B ceiling prices are calculated to match Medicaid prices net of the rebate (Dolan, 2019). Arguably, the 340B drug discount is more important than the Medicaid MFN, because many more drug purchases are entitled to 340B discounts than Medicaid rebates. The U.S. Government Accountability Office estimated that more than 50 percent of total sales of some drugs were 340B eligible (2015).

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the Department of Health and Human Services (HHS) and report their best price for brand name drugs. HHS uses this price data to calculate the unit rebate amount (URA) based on the rebate formula and inflationary component and provides the URA to states. States multiply the units of each drug purchased by the URA and invoice the drug maker for that amount. Drug makers then pay states the statutory rebate amount as well as any negotiated supplemental rebates.

[13]Medicaid enrollees are diverse in their reasons for eligibility and medical needs: Medicaid covers many infants, children, pregnant women, and some parents of Medicaid eligible children, but also many people with disabilities, and elderly people with very low incomes. The Affordable Care Act (ACA) expanded Medicaid coverage of low-income, non-disabled, childless adults. The ACA made significant changes to the MDRP. The law increased the rebate amount for both branded drugs and generic drugs. It also extended rebates to outpatient drugs purchased for beneficiaries covered by Medicaid managed care organizations (MCOs). Previously, only drugs purchased through Medicaid fee-for-service were eligible for rebates even though most states contract with MCOs to provide services to Medicaid beneficiaries.

[14]Earlier studies of the MDRP program have found that MDRP modestly increased the price of some drugs (Scott Morton, 1996).

3 Model Setup

Our model describes a stylized setting in which multiple makers of branded drugs sell their products on formularies run by intermediaries. The intermediaries in our setup are either health insurers (payers) or a PBM hired by the payers. In either case, customers must enroll in an insurance plan and pay the plan's premium to gain access to drugs sold on the formulary. Drug makers compete for a preferred formulary position by offering higher rebates, i.e., by lowering the net price at which they sell drugs to the intermediary.

3.1 Drug Makers

Each drug maker produces a drug targeted at a distinct disease. The drugs are produced at zero marginal cost, but each is patent protected so that the drug maker is a monopolist in its own product market.[15] Drug maker i has a list price, $\bar{p}_i$ at which it sells its drug to the uninsured who lack access to a formulary. We initially treat the list prices as exogenous, but allow them to be chosen endogenously in an extension to the basic model.

Drug makers compete for a preferred position in the formulary by selling drugs to the intermediary at a net price that is below their list price. Thus, the net price for drug i is $p_i \leq \bar{p}_i$. The difference between the list price and the net price at which the drug is sold to the formulary is the per unit rebate. In our baseline model, the drugs treat separate and unrelated diseases—clinically they are neither substitutes nor complements. In an extension, we consider branded drugs that are clinically partial substitutes. Drug makers choose prices to maximize profit, which is equal to the net price times the quantity of drug sold. The quantity, of course, depends on the copay in the formulary tier to which the intermediary assigns the drug. In most of our analyses, there are two drug makers; in an extension we also consider the general case with $m \geq 2$ drug makers.

[15] Here we follow Scherer (1993); Scott Morton (1999, 2000); Grabowski and Vernon (1992) in treating drug makers as monopolists in their own market.

3.2 Payers, PBMs, and Formularies

Each payer is also assumed to be a monopolist in its market. Payers receive a premium payment, p_0, from enrollees, and subsidize drug transactions on the formulary. The magnitude of the per transaction subsidy is the difference between the price they are charged for the drug and the copay in the formulary tier to which the drug is assigned.

Should payers themselves act as the intermediary between drug makers and consumers, they are charged the net price for each drug. When a payer delegates operation of the formulary to a PBM, the flow of funds is altered. The PBM pays the net price for the drugs to the drug maker but charges the payer a (possibly higher) reimbursement price, r_i, for drug i. When a consumer purchases a drug, he or she pays a copay to the PBM. The PBM then charges the payer the difference between the reimbursement price and the copay. By setting a high reimbursement price, the PBM can transfer surplus from the payer to itself.

In some versions of our model, payers will operate the formulary, and in others, the PBM takes on this role. Indeed, part of the purpose of the model is to explain why payers may delegate the formulary function to PBMs. The entity in charge of the formulary specifies a copay for each tier: drugs assigned to the preferred tier have a low copay, c_L, and drugs assigned to the non-preferred tier have a high copay, c_H. The formulary operator decides the rules assigning drugs to tiers. The greater the difference in copays across tiers, the greater the value to the drug makers of winning a preferred formulary position. As we will show, the formulary assigns drugs to tiers by comparing the net prices (or equivalently, rebates) offered by the drug companies. In this way, the formulary creates an "all-pay" contest where the bidding takes the form of drug makers offering rebates off list prices. Abusing notation slightly, we denote the copay assigned to drug d by c_d, where c_d takes on the value c_L if drug d was assigned to the preferred tier, or c_H otherwise.

When a payer is the intermediary, it chooses the premium p_0, copays c_L and c_H, and drug tier assignments that maximize its profit. Payer profit in this case is equal to the revenues they get from premiums minus the cost of drug subsidies. Drug

subsidy costs are the product of net price minus copay and the volume of drug sold.

3.3 Consumers

Consumers purchase health insurance when healthy, and then become patients in need of treatment. Treatment consists of purchasing one of the two branded drugs, depending on which illness becomes manifest. We model uncertainty over the type of medical condition as a discrete random variable $D \in \{1, 2\}$ with $\Pr(D = i) = 1/2$ for $i \in \{1, 2\}$. Consumer willingness to pay for the treatment depends on illness severity, which we denote by random variable V with complementary cdf denoted by $q(p) := \Pr(V > p)$, independent of D. We refer to $q(p)$ as the consumer demand function and assume that it is strictly downward sloping and differentiable on the support of V. In some illustrative special cases, we assume it is uniform on the unit interval, which corresponds to a linear demand curve. Our baseline model does not rely on this assumption.

Consumers who enroll in insurance pay a premium p_0 to gain access to the formulary. If the drug that becomes relevant for their condition ends up in the preferred tier, the consumer pays the low copay, c_L. If the relevant drug is in the other tier, they pay a high copay, $c_H \geq c_L$. Thus, consumers using the formulary face a two-part pricing schedule for accessing drugs: an upfront fixed premium and a copay per unit of drug purchased. Contrary to conventional two-part pricing, however, the marginal cost of the drug to the formulary is endogenous to the copays the intermediary assigns to the formulary tiers.

Regardless of insured status, consumers also have the option to purchase a drug at its list price out of pocket. In our baseline model, we assume that these list prices are identical and exogenously determined to be $\bar{p}$. In subsequent sections, we relax this assumption in order to examine more fully the economics of list prices.

Consumers decide whether to purchase health insurance and whether to purchase a drug by maximizing expected utility. Utility is equal to V minus the sum of the amount paid for the drug (if he or she purchases the drug relevant to his or her clinical condition) and the premium (if he or she purchases insurance coverage), and

zero otherwise.

3.4 Discussion of Model Assumptions

This section discusses three simplifying assumptions our model makes and the consequences of relaxing them.

First, our model assumes that each drug maker offers the intermediary a single net price that applies whether or not the drug is awarded preferred formulary placement. An alternative modeling assumption is to allow drug makers to offer contingent net prices: one that applies if the drug is awarded the preferred tier, and another if it is not. In Appendix B we solve the model under the alternative with contingent net prices and show the equilibrium allocation and distribution of surplus are unaffected. The difference is that in the baseline model, drug makers set their net price via a mixed strategy equilibrium, whereas in the contingent net price alternative, the equilibrium involves pure strategies. The pure strategy equilibrium results in identical allocation and distribution of surplus.

Second, we assume consumers are identical before their health shocks are realized. This assumption simplifies the analysis by ruling out any problems with adverse selection - an important issue in insurance markets, but not the focus of this paper. This simplification also implies that consumer surplus above the out-of-pocket outside option can be fully extracted by the insurance premium. If we introduce ex ante heterogeneity among consumers in their valuation of insurance, we would create a downward sloping demand curve for insurance. In this case, some consumers would enjoy consumer surplus and our result that *all* surplus from the formulary accrues to the intermediary would thus be softened.

Third, we assume consumers are risk neutral. Risk aversion would provide another channel whereby the formulary provides value in the market and another force encouraging low copays. We assume risk neutrality to highlight that even in the absence of risk aversion, formulary incentives lead to low copays and they enhance efficiency by replacing distortionary monopoly pricing with a premium and copay mechanism that approximates a two-part tariff. In our setup, even risk neutral con-

sumers purchase health insurance because it gives them access to subsidized drugs. Assuming that consumers were either risk averse (Rothschild and Stiglitz, 1976; Zeckhauser, 1970) or liquidity constrained (Ericson and Sydnor, 2018) would likely have the additional effect of reducing the high copay associated with the non-preferred tier.

4 Baseline model: Payer operates the formulary

In the baseline model, a single payer operates a formulary that allocates two drugs to two tiers. The list price for each drug is exogenously set to $\bar{p}$, the monopoly price of the drug. The timing is as follows:

1. the payer chooses the formulary copays c_L and c_H;
2. drug makers set net prices p_1 and p_2;
3. the payer assigns drugs to formulary tiers and sets the premium, p_0;
4. consumers decide whether to purchase insurance;
5. nature chooses the consumer's medical condition, D, and its intensity, V;
6. consumers decide whether to purchase the drug relevant to their condition.

4.1 Equilibrium

We describe each player's equilibrium strategy by working backwards. Consumers decide whether to purchase a drug, taking list prices, copays, tier assignments, their health insurance enrollment decision, their medical condition D, and its intensity V as given. Consumers who enrolled in health insurance purchase the drug corresponding to their medical condition if either the copay or the list price is less than their willingness to pay for the drug, V. Consumers who do not enroll in insurance purchase the drug if the list price is less than V. Consumers decide whether to enroll in insurance taking list prices, copays, tier assignments, and the premium as given.

Consumers enroll in insurance if their expected utility with insurance exceeds their expected utility without insurance by the amount of the premium. Expected utility without insurance is

$$U_0 := E\left[(V - \bar{p})\, 1\left(V > \bar{p}\right)\right].$$

Expected utility with insurance is

$$U_1 = \frac{1}{2}\sum_{i=1}^{2} E\left[(V - \min\left\{c_i, \bar{p}\right\})\, 1\left(V > \min\left\{c_i, \bar{p}\right\}\right)\right].$$

The following lemma formalizes the consumer's equilibrium strategies.

Lemma 1 (**Consumer insurance and drug purchase decisions**). *In the baseline model with the payer operating the formulary, in every subgame-perfect Nash equilibrium, drug purchasing and insurance enrollment decisions are as follows. Consumers who enrolled in the insurance plan and have medical condition $D = d$ purchase drug d if and only if $V \geq \min\left\{c_d, \bar{p}\right\}$. They purchase it through the formulary if $c_d \leq \bar{p}$ and out-of-pocket otherwise. Consumers who did not enroll in insurance purchase drug d if and only if $D = d$ and $V \geq \bar{p}$. Consumers enroll in insurance if and only if*

$$p_0 \leq U_1 - U_0. \tag{1}$$

Next, consider the health insurer's choice of premium and tier assignment. The payer chooses the premium taking list prices, net prices, and the tier assignment as given, and does so to maximize its expected profit, which is equal to the premium minus drug subsidies,

$$\pi_{\text{payer}}\left(p_0, c_1, c_2, p_1, p_2\right) = p_0 - \frac{1}{2}\left(\left(p_1 - c_1\right) q\left(c_1\right) + \left(p_2 - c_2\right) q\left(c_2\right)\right),$$

if consumers purchase insurance, and equal to zero otherwise. The payer will set the premium so the consumer's enrollment condition, (1), binds, if the profit from doing so is nonnegative; otherwise it will set a premium that is higher, resulting in a profit of zero. The payer makes the tier assignment taking list prices and net prices

as given. The payer assigns drug 1 to the preferred tier (that is, sets $c_1 = c_L$ and $c_2 = c_H$) if the profit from doing so is greater than the profit from setting $c_2 = c_L$ and $c_1 = c_H$. That is, drug 1 is assigned to the preferred tier if and only if

$$\pi_{\text{payer}}(p_0, c_L, c_H, p_1, p_2) \geq \pi_{\text{payer}}(p_0, c_H, c_L, p_1, p_2).$$

This turns out to be satisfied if and only if $p_1 \leq p_2$. The following lemma formalizes these results.

Lemma 2 (**Payer's choice of premium and tier assignment**). *In the baseline model with the payer operating the formulary, in every subgame-perfect Nash equilibrium, strategies for premium and tier assignment are as follows. The payer sets premium* $p_0 = U_1 - U_0$ *if*

$$\pi_{payer}(U_1 - U_0, c_1, c_2, p_1, p_2) \geq 0 \tag{2}$$

and $p_0 > U_1 - U_0$ *otherwise. The payer assigns drug 1 to the preferred tier (that is, sets* $c_1 = c_L$ *and* $c_2 = c_H$*) if and only if* $p_1 \leq p_2$.

Next, each drug maker takes list prices and copays as given and sets its net price to maximize expected profit, anticipating the resulting tier assignment. Drug maker 1's expected profit as a function of p_1, taking p_2 as given is

$$\pi_1(p_1; p_2) = \begin{cases} \frac{1}{2} p_1 q(c_L) & , \quad p_1 \leq p_2 \\ \frac{1}{2} p_1 q(c_H) & , \quad p_1 > p_2 \end{cases},$$

provided the payer's participation condition (2) is satisfied, and $\bar{p} q(\bar{p})/2$ otherwise. Drug maker 2's profit is defined analogously. Because $q(c_L) > q(c_H)$ whenever $c_L < c_H$ (as will be the case in equilibrium), a drug maker's profit discretely increases as it undercuts the other drug maker's net price. Consequently, there will be no pure strategy equilibrium.[16] Drug makers will play a mixed strategy where net prices are drawn from a distribution where at the lower end of the support the profit conditional

[16] Mixed strategies are a general feature of all-pay auctions (Siegel, 2009). Intuitively, suppose both drug makers offered the same price and so were equally likely to be in either tier. One drug

on winning the formulary contest is equal to the profit from setting a maximal price ($\bar{p}$) and losing. The following lemma characterizes the mixed strategy equilibrium at this stage of the game.

Lemma 3 (**Drug net price equilibrium distribution**). *In the baseline model with the payer operating the formulary, there is a unique subgame-perfect Nash equilibrium, which is symmetric and involves a continuously mixed net-price strategy. These net-price strategies are characterized by the following distribution, given copays c_L and c_H:*

$$F\left(p; c_L, c_H\right) = \begin{cases} 0 & , \quad p < \bar{p}\frac{q(c_H)}{q(c_L)} \\ \frac{q(c_L) - \frac{\bar{p}}{p}q(c_H)}{q(c_L) - q(c_H)} & , \quad \bar{p}\frac{q(c_H)}{q(c_L)} \leq p < \bar{p} \\ 1 & , \quad p \geq \bar{p} \end{cases} .$$

Note that the modal price in the equilibrium net-price distribution is also the lowest price in the support:

$$\underline{p} = \bar{p}\frac{q\left(c_H\right)}{q\left(c_L\right)}.$$

The formulary structure is identical to an all-pay contest in which drug companies bid by offering a low net price and the copays determine the size of the prize. The greater the demand for the drug at the low copay and the smaller the demand at the high copay, the greater the incentive to offer a low net price. The following lemma formalizes this effect of the formulary copays on the equilibrium net price distribution.

Lemma 4 (**Effect of copays on drug net price distribution**). *The equilibrium net-price distribution is stochastically increasing in c_L and stochastically decreasing in c_H.*

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maker could break the equilibrium by undercutting the other's price and getting placed in the preferred tier. This logic holds for a drug price above zero. Zero is not an equilibrium net price either because at this point neither drug maker is making positive profits. One drug maker could therefore increase their profits by offering a positive price and being placed in the non-preferred tier. By similar reasoning, there is also no asymmetric pure strategy equilibrium where the two drug makers offer different prices. The drug maker with the lower price can deviate by slightly raising prices. Their profits increase, and they win the preferred tier.

A consequence of the lemma is that the payer can induce lower net prices for drugs by increasing the spread between the low and high copays. However, increasing the spread introduces inefficiency because the socially optimal copays would be set equal to the marginal cost of each drug, and marginal cost is assumed to be zero. Increasing the spread between copays also affects other determinants of the payer's profit: raising c_H reduces the value of insurance coverage and thus reduces premium revenue; lowering c_L reduces copay revenue. The payer's optimal choice of c_L and c_H navigates these tradeoffs and (as we show formally in the proposition below) results in a socially inefficient (but profit-maximizing) spread between the low and high copay. The following lemma describes the optimal copays for the payer.

Lemma 5 (**Optimal copays**). *Suppose* $\bar{p} \leq q^{-1}(0)$. *Then the profit-maximizing choices of copays are* $c_L = 0$ *and* $c_H = \bar{p}$.

In summary, in the baseline model where the payer operates the formulary, the equilibrium formulary consists of a preferred tier with a copay of zero and a non-preferred tier with a copay equal to the list price; drug makers compete for the preferred position on the formulary by offering a distribution of net prices, or, equivalently, rebates; and the payer sets the premium to extract surplus from consumers. To build intuition for these and subsequent results, the next subsection offers a graphical representation of the model.

4.2 Graphical Representation of the Formulary

We can build intuition for the model by representing it graphically in the special case of a linear demand curve ($q(p) = 1 - p$). The main economic forces in the model are captured in the tradeoff the intermediary faces in setting the formulary copays. Figure 2 illustrates several aspects of this tradeoff, plotting total surplus and combined drug profit and consumer surplus as functions of the low copay, c_L, holding c_H fixed at $\bar{p}$. The difference between the two curves is the payer's profit. Reducing the low copay has several countervailing effects on the profit produced by the formulary. First, reducing the copay increases drug purchases, which increases

total surplus, as shown in the solid blue curve in Figure 2. This also increases the value of insurance, which the payer captures by charging higher premiums. Consumer surplus is thus unaffected by the payer's choice of copays.

Reducing the low copay also increases the value to drug makers of winning the formulary contest. This potential benefit to drug makers is competed away as drug makers offer a stochastically lower distribution of net prices, as shown in Lemma 4. In equilibrium, therefore, drug makers always receive a payoff equal to what they would earn if they lose the tournament and are assigned to the non-preferred tier. For this reason, drug maker profit is also unaffected by payer's choice of low copay. The constant consumer surplus and drug maker profit is represented by the horizontal dashed red curve in the figure. The difference between the two curves is the payer's profit from operating the formulary. Because total surplus increases as the copay in the preferred tier decreases, while consumer surplus and drug maker profit remain flat, the payer's profit is maximized at $c_L = 0$.

5 Efficiency Enhancing Extensions: Clinical Substitutes and Many Drugs

The baseline model considers a formulary composed of two branded drugs, each of whose demand is entirely independent of the other. This simple setup highlights how the economic properties of the formulary emerge from competition for a preferred formulary slot. In this section, we introduce two extensions to the basic design. The first allows the branded drugs on the formulary to be clinical substitutes. The second allows the formulary to include more than two drugs. Each of these extensions heightens the competition between drug makers and enhances the efficiency of the equilibrium allocation.

5.1 Substitution between branded drugs

The baseline model assumes that branded drugs treat distinct conditions and are not substitutes. In this section, we extend the model to allow substitution between

branded drugs.

Taking the baseline model in Section 4 as the starting point, we introduce substitution between drugs by allowing for a fraction $\tau \in [0,1]$ of consumers to benefit equally from either drug; the remaining fraction $1-\tau$ only benefit from a single drug. The probability of being able to substitute between drugs is independent of illness severity and type. The fraction τ of consumers purchase the drug with the lower copay if their willingness to pay V exceeds the lower copay. The remaining fraction purchases the drug corresponding to their condition if their willingness to pay exceeds that drug's copay.

Equilibrium behavior in this extension to the model is similar to the baseline model, as the proposition below formalizes. Specifically, the drug with the lowest net price is assigned to the preferred tier, and drug makers set net prices via mixed strategies of similar form to the baseline model, although the distribution is stochastically lower. Optimal copays are unchanged.

Proposition 1 (**Substitution increases formulary efficiency and decreases drug maker profit**). *In the symmetric subgame-perfect Nash equilibrium with substitution between drugs, optimal copays are*

$$\begin{aligned} c_L &= 0, \\ c_H &= \bar{p}, \end{aligned}$$

total surplus is

$$TS = \frac{1}{2}\left((1+\tau)\,E\left[V1\left(V \geq c_L\right)\right] + (1-\tau)\,E\left[V1\left(V \geq c_H\right)\right]\right),$$

consumer surplus is

$$CS = E\left[\left(V-\bar{p}\right)1\left(V > \bar{p}\right)\right],$$

drug maker profit is

$$\pi_{drug\ maker} = \bar{p}\,(1-\tau)\,q\left(c_H\right),$$

and the equilibrium drug net price distribution is stochastically decreasing in the

degree of substitution, τ.

In sum, allowing for partial clinical substitution on the formulary leaves optimal copays unchanged and consumer surplus unchanged, but increases total surplus and reduces drug maker profit. The additional surplus from substitution therefore accrues to the intermediary. The reason for this result is that substitution heightens the competition among the drug makers for the coveted preferred tier placement, resulting in a lower equilibrium net price distribution.

5.2 Formularies with Many Drugs: Approximately Efficient

Intermediaries in the drug market can attract consumers and drug makers because the formulary generates a larger economic surplus than the alternative of drug makers selling directly to consumers at monopoly prices. Indeed, if this were not so, it would be hard to explain the presence of intermediaries in this market.

In principle, intermediaries could generate even more surplus by adopting an efficient two-part pricing strategy where consumers pay a premium for access to the formulary plus a copay equal to the marginal cost of each drug (which in our model is zero). In Section 4, however, we showed this was not the case in our baseline model: instead, the payer sets one of the copays to the list price which is set at the monopoly price. The result is some deadweight loss: there exist consumers with willingness to pay higher than the marginal cost of producing the drug who do not receive the drug.

The inefficiency of our formulary is entirely due to the high copay for the drug assigned to the non-preferred tier. This raises the question of how many slots the payer will optimally create for drugs in the non-preferred tier. Extending our model to the case where there are many drugs, we find that in equilibrium only one drug is assigned to the non-preferred tier. The remaining drugs are sold using the efficient two part pricing. This result suggests that formulary tournaments are "approximately" efficient. Indeed, when the clinical conditions treated by the drugs are equally distributed in the population, the allocation approaches full efficiency as the number of drugs grows.

To allow for many drugs we assume that consumers are equally likely to fall ill with one of $m \geq 2$ medical conditions. Each of these conditions is treated by a different branded drug produced by a different drug maker. The payer assigns each of the $m \geq 2$ drugs to one of m formulary tiers, each with an associated copay, $c_1, c_2, \ldots, c_m$, where $c_1 \leq c_2 \leq \cdots \leq c_m$. The timing of decisions is the same as in the baseline model.

Equilibrium behavior in this extension is similar to that in the baseline model. Specifically, the payer assigns drugs to tiers in order of the net price, with the drug whose net price is lowest being placed in the most preferred tier. Drug makers also set net prices using mixed strategies where the net price distribution includes the list price as its upper bound.

Most importantly, the payer in equilibrium sets all copays but one to zero, and it sets the remaining copay to the list price. In other words, the optimal formulary design includes two tiers: a preferred tier with a copay of zero that includes all drugs but one, and a non-preferred tier with a copay equal to the list price to which the remaining drug is relegated. The fact that all but one of the drugs are assigned a copay of zero means the equilibrium is approximately efficient: as the number of drugs m increases, the equilibrium converges to full efficiency. The following proposition formalizes these results.

Proposition 2 (**Formulary equilibrium with m drugs is approximately efficient**). *Equilibrium copays with m drugs are as follows:*

$$\begin{aligned} c_1 &= c_2 = \cdots = c_{m-1} = 0; \\ c_m &= \bar{p}, \end{aligned}$$

and equilibrium total surplus is

$$TS = E[V] - \frac{1}{m} E[1(V \leq \bar{p})\, V].$$

Because the first-best surplus is $E[V]$, the result means that as m increases, equilibrium surplus converges to full efficiency. For any given number of drugs, m,

however, the equilibrium is inefficient. The inefficiency stems entirely from the drug assigned to the non-preferred tier where the copay is nonzero. Why doesn't the intermediary assign all drugs to a tier with a copay of zero and thereby achieve a fully efficient equilibrium? The reason is that the possibility of being relegated to a non-preferred tier, even if the probability is only $1/m$, induces drug makers to offer substantial rebates off list price, increasing profit for the intermediary. If all tiers had a copay of zero, drug makers would offer no rebates.

6 Why Do Payers Delegate Formulary Operations to a PBM Acting as a Common Agent for Many Payers?

We have argued that formularies generate economic surplus relative to the alternative of selling drugs at monopoly prices. Nothing in our analysis so far suggests that these formularies need to be operated by PBMs. In this section, we pose the following question: why would payers delegate such a critical and potentially profitable function to a PBM acting as a common agent for many payers?

Our answer builds on a contracting externality found in pharmaceutical markets, most favored nation (MFN) clauses. As described in Section 2, MFN clauses require that the net prices offered to a specific purchaser be at least as low as those offered to any other purchaser in the market. MFN clauses create the following externality. If one formulary manages to win lower average net drug prices, the average net drug prices offered to other formularies with MFN clauses in their contracts must also decline. Since providing higher-powered incentives is costly to the formulary operator, when the formulary does not capture all the benefits of a reduction in net prices, equilibrium formulary incentives are weakened. Weaker formulary incentives increase average net drug prices and also reduce the efficiency of drug markets. Large PBMs acting as a common agent for many payers can better internalize this externality. As a result, equilibrium incentives become more powerful, average net drug prices fall and market efficiency increases. These efficiency gains favor delegation of formulary

operations to PBMs acting as a common agent for many payers.

Industry observers typically assert that MFN clauses are widespread, but the terms of these contracts are closely held secrets and so these assertions are rarely based on direct knowledge. We have consulted, however, with economists and lawyers who work directly with these contracts and they confirm that MFN clauses are ubiquitous. In addition to these private contractual clauses, Medicaid and the 340B program have statutorily mandated MFN clauses, as described in Section 2. These also introduce contracting externalities because purchasers under these programs use the same PBMs.

In what follows, we analyze the effects of this contracting externality in detail. We first consider the case with several payers and no PBM, and then the case with a single PBM acting as a common agent. In both cases, we revert to our baseline assumptions that there are only two drugs and that the list prices for these drugs are exogenously set to $\bar{p}$.

6.1 Equilibrium with Several Payers: Contracting Externalities in the Absence of PBMs

We return to the baseline model with two drugs but extend it to two payers, indexed by $j \in \{1, 2\}$. Each payer is a monopolist in its own segment of the insurance market and serves consumers with mass $1/2$. The timing is as follows:

1. Each payer $j \in \{1, 2\}$ sets formulary copays c_L^j and c_H^j;
2. drug makers set net prices p_1 and p_2;
3. each payer assigns drugs to formulary tiers and sets p_0^j;
4. consumers decide whether to purchase insurance;
5. nature chooses the consumer's medical condition, $D \in \{1, 2\}$, and its intensity, V;
6. consumers decide whether to purchase the drug.

At each stage, these choices are made simultaneously and noncooperatively with the other payer. To reflect the existence of MFN clauses or other frictions, drug makers continue to set net prices p_1 and p_2, which apply to all payers. As before, we describe each player's equilibrium strategy in the usual way, working backwards. Consumers' drug purchasing decisions and insurance enrollment decisions are unchanged from the single payer case (see Lemma 1), except naturally consumers in payer j's market make their decision based on p_0^j, c_1^j and c_2^j. That is, a consumer in payer j's market enrolls in insurance, if and only if

$$p_0^j \leq U_1^j - U_0,$$

where

$$U_1^j = \frac{1}{2}\sum_{i=1}^{2} E\left[\left(V - \min\left\{c_i^j, \bar{p}\right\}\right) 1\left(V > \min\left\{c_i^j, \bar{p}\right\}\right)\right].$$

Each payer's choice of premium and tier assignment are also unchanged from the result in Lemma 2: payer j's premium is

$$p_0^j = U_1^j - U_0,$$

as long as its profit is positive, and it assigns $c_1^j = c_L^j$ and $c_2^j = c_H^j$ if $p_1 \leq p_2$.

Drug makers' net price choices are similar, except drug maker profit now depends on the aggregation of consumer demand for the drug across each payer's copays. Drug maker 1's profit as a function of its own net price, taking drug 2's net price as given is

$$\pi_1(p_1; p_2) = \begin{cases} \frac{1}{2} p_1 \bar{q}(\mathbf{c}_L) & , \quad p_1 \leq p_2 \\ \frac{1}{2} p_1 \bar{q}(\mathbf{c}_H) & , \quad p_1 > p_2 \end{cases},$$

where $\bar{q}(\mathbf{c}_L) = \left(q\left(c_L^1\right) + q\left(c_L^2\right)\right)/2$ and $\bar{q}(\mathbf{c}_H) = \left(q\left(c_H^1\right) + q\left(c_H^2\right)\right)/2$. Similar to the single-payer case described in Lemma 3, drug makers choose a mixed strategy net-

price distribution with the following cumulative distribution function:

$$F\left(p;\mathbf{c}_L,\mathbf{c}_H\right)=\begin{cases}0 & , \quad p<\bar{p}\frac{\bar{q}(\mathbf{c}_H)}{\bar{q}(\mathbf{c}_L)}\\ \frac{\bar{q}(\mathbf{c}_L)-\frac{\bar{p}}{p}\bar{q}(\mathbf{c}_H)}{\bar{q}(\mathbf{c}_L)-\bar{q}(\mathbf{c}_H)} & , \quad \bar{p}\frac{\bar{q}(\mathbf{c}_H)}{\bar{q}(\mathbf{c}_L)}\leq p<\bar{p}\\ 1 & , \quad p\geq\bar{p}\end{cases}.$$

The payers' choices of copays c_L^j and c_H^j are different from the single payer case. The reason is that an individual payer's choice of copay has less influence on drug prices, because drug prices respond only to the aggregate incentives provided by all payers. As a result, the marginal benefit of setting a low preferred tier copay (which encourages drug makers to set low net prices) decreases with the number of payers. The following proposition formalizes this argument.

Proposition 3 (**With multiple payers, contracting externalities increase the copay in the preferred tier, reduce payer profits, and reduce total surplus**). *In any symmetric equilibrium, the copay in the preferred tier, c_L, is greater than zero, and total payer profit and total surplus are lower than in the one-payer case.*

The proposition states that when multiple payers operate their own formularies, contracting externalities weaken incentives for drug makers to lower prices and reduce total profit to the payers. Figure 3 illustrates the effect of these externalities in the special case of linear demand when we go from $n = 1$ payer to $n = 2$ payers. The blue line in the drawing depicts total surplus generated by pharmaceutical sales. The red dashed line represents the combined consumer surplus and drug maker profit. The black dashed curve shows combined consumer surplus, drug maker expected profit, and the other payer's profit. Consumer surplus and drug maker profit do not depend on the low copay. The premium extracts all consumer surplus beyond the outside option which is determined by the list price. Drug maker expected profit in the formulary tournament is determined by the "loser's" reward, which is a function of the high copay only. The difference between the black and the red curves is the other payer's profit, which increases as the one payer's low copay decreases. This reflects the contracting externality: as one payer's low copay falls, other payers benefit from

lower net drug prices. Because formularies do not capture the full benefit of lower drug prices, the payer's profit is no longer maximized at $c_L = 0$, but rather at a strictly higher value. Higher copays in the preferred tier also reduce consumers' consumption and consequently reduce efficiency.

6.2 PBM Acting as a Common Agent Internalizes the Externality

The previous section found that when several payers operate their own formularies, externalities lead to reduced profits, high drug net prices, and lower total surplus. In this section, we consider how a PBM acting as a common agent for many payers can internalize the externality and so raise joint profits among payers and the PBM, and improve market efficiency. To make this argument, we introduce a single PBM that operates a formulary on behalf of many payers. The PBM specifies copays, assigns drugs to tiers, and sets reimbursement prices r_1 and r_2 which payers must remit to the PBM for each drug transaction.

An important feature of this version of the model is that the price of drugs to payers (reimbursement prices) may differ from the net price a drug company charges the PBM. Indeed, the spread between reimbursement prices and net prices is an important source of profits for PBMs. A second key feature is that the PBM offers a contract to each payer in which the payer delegates operation of the formulary to the PBM in exchange for a transfer. The contract offer to each payer is contingent on all other payers accepting the contract. This set up allows for the possibility of trivial equilibria in which all or some payers refuse the contract. We focus our analysis on the principal's preferred equilibrium in which all payers accept the contract (Segal, 1999). We continue to assume that there are only two drugs and that list prices are set exogenously at the monopoly price of the patented drugs. The timing of events is as follows:

1. the PBM simultaneously offers a contract to each payer in which the payer delegates formulary operation to the PBM and the PBM in exchange makes a

transfer of π_0 to each payer; each payer chooses whether to accept the PBM contract or to reject in favor of acting as its own intermediary;

2. the PBM chooses the formulary copays c_L and c_H; these copays are common for all payers contracting with the PBM;

3. drug makers set net prices p_1 and p_2;

4. the PBM assigns drugs to formulary tiers and sets reimbursement prices r_1 and r_2;

5. the payer sets the premium p_0;

6. consumers decide whether to purchase insurance;

7. nature chooses the consumer's medical condition, D, and its intensity, V;

8. consumers decide whether to purchase the drug.

As before, consumers purchase insurance if the premium is less than the utility gain from doing so:

$$p_0 \leq U_1 - U_0,$$

where utilities are the following:

$$\begin{aligned} U_0 &= E\left[(V - \bar{p})\, 1\left(V > \bar{p}\right)\right] \\ U_1 &= \frac{1}{2}\sum_{i=1}^{2} E\left[\left(V - \min\left\{c_i, \bar{p}\right\}\right) 1\left(V > \min\left\{c_i, \bar{p}\right\}\right)\right]. \end{aligned}$$

The payer chooses the premium to maximize its profit:

$$\pi_{\text{payer}}\left(p_0, c_1, c_2, r_1, r_2\right) = p_0 + \frac{1}{2}\sum_{i=1}^{2} q\left(c_i\right)\left(c_i - r_i\right).$$

Because profit is increasing in the premium, the payer chooses the premium so that the consumer's insurance decision condition binds, as in Lemma 2:

$$p_0 = U_1 - U_0,$$

as long as its profit is nonnegative.

The PBM sets reimbursement prices and makes tier assignments to maximize its profit,

$$\pi_{\text{PBM}}\left(c_1, c_2, r_1, r_2; p_1, p_2\right) = \frac{1}{2}\sum_{i=1}^{2} q\left(c_i\right)\left(r_i - p_i\right), \tag{3}$$

subject to the constraint that the payer's profit is nonnegative, and taking net prices as given. The PBM's profit is increasing in the reimbursement prices, meaning the PBM will set r_1 and r_2 so that the payer's profit condition binds. This determines the weighted average reimbursement price, but it does not pin down the individual reimbursement prices separately because the payer's profit depends on the reimbursement prices only through their weighted average. As in the baseline model where the payer was the intermediary, the PBM maximizes profit by assigning drugs to tiers by a simple comparison of the net prices. The following lemma establishes these results.

Lemma 6 (**PBM's choice of reimbursement prices and tier assignment**). *In the PBM model with exogenous list prices, the PBM sets reimbursement prices to satisfy*

$$\frac{1}{2}\sum_{i=1}^{2} q\left(c_i\right) r_i = p_0 + \frac{1}{2}\sum_{i=1}^{2} q\left(c_i\right) c_i.$$

The PBM assigns drug 1 to the preferred tier (that is, sets $c_1 = c_L$ and $c_2 = c_H$) if and only if $p_1 \leq p_2$.

The fact that the PBM is acting as common agent does not change the drug makers' problem in setting net prices. The mixed strategy equilibrium determining

the net price distribution is identical to the baseline model:

$$F\left(p; c_L, c_H\right) = \begin{cases} 0 & , \quad p < \bar{p}\frac{q(c_H)}{q(c_L)} \\ \frac{q(c_L) - \frac{\bar{p}}{p} q(c_H)}{q(c_L) - q(c_H)} & , \quad \bar{p}\frac{q(c_H)}{q(c_L)} \leq p < \bar{p} \\ 1 & , \quad p \geq \bar{p} \end{cases} .$$

Likewise, after substituting the PBM's reimbursement price choice shown in Lemma 6 into the PBM's profit function, (3), the PBM's profit is identical to the payer's profit in the baseline model. Consequently, the PBM's choice of copays is identical to the baseline model. That is, the PBM will set $c_L = 0$ and $c_H = \bar{p}$. The PBM thus resolves the externality in the previous section when several payers acted as intermediaries on their own. The result is that when a PBM acts as intermediary, the joint profit among the PBM and payers is higher than when payers act as intermediary and total surplus is higher, as the following proposition formalizes.

Proposition 4 (**When payers select a PBM as a common intermediary, total surplus and joint profits rise**). *Suppose there are two payers. Total surplus and joint PBM and payer profit is higher when the PBM acts as a common intermediary than when payers act as their own intermediaries.*

This result provides the economic rationale for the intermediary role PBMs play in the industry. When several payers each act as their own intermediary, pricing externalities among them raise drug prices and reduce profits. Payers can do better by delegating formulary design to a common agent, the PBM. The presence of a PBM not only raises joint profit among the payers and the PBM but also improves efficiency because the PBM will choose a lower copay in the preferred tier than payers would on their own. Thus, in the first step of the model, all payers accept the PBM's contract so long as the transfer, π_0, is greater than the equilibrium profit when each payer operates its own formulary.

7 Endogenous List Prices

In this section, we analyze the economics of list prices by allowing the two drug makers to set list prices endogenously. We will find that list prices matter because they determine consumers' outside options. High list prices reduce the value of purchasing drugs outside the formulary and so make participating in the formulary more valuable for consumers. PBMs can capture this increase in value and so will bias formulary incentives *in favor* of drugs offering high list prices. The result is an equilibrium in which the list prices of some drugs become detached from their underlying clinical value and the average list price exceeds the monopoly price. These high list prices increase the joint surplus of drug makers and PBMs, but they reduce consumer surplus and make drug markets less efficient.

To accommodate endogenous list prices, we extend our baseline model by allowing drug makers to choose their respective list prices, $\bar{p}_1$ and $\bar{p}_2$, before the formulary design is chosen. For ease of exposition, we assign the label "drug 1" to the drug with the (weakly) lower list price, so that without loss of generality $\bar{p}_1 \leq \bar{p}_2$. Unequal list prices allow for the possibility that c_H may be lower than one list price, but not the other. In this case, if the drug with the lower list price is placed in the non-preferred tier, we assume that the effective copay reverts to that drug's list price.[17] For example, if $\bar{p}_1 < c_H \leq \bar{p}_2$, and drug 1 "loses" the formulary tournament so that it is assigned to the non-preferred tier, we assume the copay charged consumers would be $\bar{p}_1$, while if drug 2 were to lose, the copay would be c_H. To simplify our analysis, we return to our baseline assumption that a single payer operates a single formulary.

The timing is as follows:

1. drug makers simultaneously choose list prices $\bar{p}_1$ and $\bar{p}_2$;
2. the payer chooses the formulary copays c_L and c_H, where $0 \leq c_L \leq c_H \leq \bar{p}_2$;
3. drug makers set net prices p_1 and p_2;

[17] This assumption is without loss of generality: it is optimal for payers to set copays no higher than the list price because consumers have the option to purchase at the list price out of pocket. The substantive assumption here is that consumers cannot commit to giving up their option to purchase at the list price.

4. the payer assigns drugs to formulary tiers and sets the premium p_0;

5. consumers decide whether to purchase insurance;

6. nature chooses the consumer's medical condition, D, and its intensity, V;

7. consumers decide whether to purchase the drug.

As before, consumers purchase insurance if the premium is less than the utility gain from doing so, that is, if $p_0 \leq U_1 - U_0$, where utilities now are functions of both list prices:

$$\begin{aligned} U_0 &= \frac{1}{2}\sum_{i=1}^{2} E\left[\left(V - \bar{p}_i\right) 1\left(V > \bar{p}_i\right)\right], \\ U_1 &= \frac{1}{2}\sum_{i=1}^{2} E\left[\left(V - \min\left\{c_i, \bar{p}_i\right\}\right) 1\left(V > \min\left\{c_i, \bar{p}_i\right\}\right)\right]. \end{aligned}$$

The payer's choice of premium is unchanged from the result in Lemma 2: $p_0 = U_1 - U_0$, as long as its profit is positive. Tier assignment, however, differs importantly: the possibility of different list prices means the rule for tier assignment is not a simple comparison of net prices. Instead, the formulary tournament may be tilted in favor of one drug or the other, as the following result shows:

Lemma 7 (**Choice of tier assignment with endogenous list prices**). *The intermediary assigns drug 1 to the preferred tier (that is, sets $c_1 = c_L$ and $c_2 = c_H$) if and only if $p_2 \geq \phi\left(p_1\right)$, where $\phi\left(p\right) = p$ if $c_H \leq \min\left\{\bar{p}_1, \bar{p}_2\right\}$ (Case 1), and*

$$\phi\left(p\right) = \frac{q\left(c_L\right) - q\left(\bar{p}_1\right)}{q\left(c_L\right) - q\left(c_H\right)} p + \frac{E\left[V | V > \bar{p}_1\right] q\left(\bar{p}_1\right) - E\left[V | V > c_H\right] q\left(c_H\right)}{q\left(c_L\right) - q\left(c_H\right)}$$

if $\bar{p}_1 < c_H \leq \bar{p}_2$ (Case 2).

The lemma shows that when list prices differ, the intermediary may bias the formulary contest. When both list prices exceed the high copay (Case 1), the tier assignment is as before: the drug with the lower net price is placed in the preferred

tier. But when one of the list prices is lower than the high copay, the formulary compares the higher list-price drug's net price, p_2, to a transformation of p_1, rather than to p_1 itself. In equilibrium, this second rule is chosen so that the formulary is biased toward the drug with the higher list price. Why would the PBM favor the drug with the higher list price? There are two reasons. First, consumers derive more value from insurance when the formulary favors the higher list price drug rather than the lower list price drug. Therefore, biasing the formulary toward the higher list price drug raises the amount of surplus the payer can extract in the premium. Second, when the drug with the lower list price (drug 1) loses the formulary contest, the high copay is only $\bar{p}_1$, not c_H. Consequently, the impact on total surplus is smaller if drug 2 were to lose the formulary contest. Because the payer can extract the increase in total surplus via the premium, it biases the formulary to make it more likely for drug 2 to win.

A biased formulary encourages high list prices. We show this in the special case of linear demand for the drugs: $q(p) = 1 - p$ for $p \in [0, 1]$ with unit demand when $p < 0$ and zero demand for $p > 1$. In this case, as we show below, drug maker 2 sets its list price to the maximum possible, $\bar{p}_2 = 1$, and drug maker 1 sets its list price to the monopoly level: $\bar{p}_1 = 1/2$. Before presenting the formal proposition, we build intuition for the result by describing the basic tradeoffs faced by drug makers and the intermediary in the formulary contest. In the formulary contest, drug makers can always earn their **default payoff** simply by bidding their list price and losing for certain. For drug maker 1, this payoff is $\underline{\pi}_1(\bar{p}_1; c_H) = q(\min\{\bar{p}_1, c_H\})\bar{p}_1/2$, and for drug maker 2 it is $\underline{\pi}_2(\bar{p}_2; c_H) = q(c_H)\bar{p}_2/2$. Any payoff above this amount we term **contest rents**. In the baseline version of the model where drug makers are symmetric, contest rents are always zero. When list prices are allowed to differ, the contest participants are no longer on an equal footing, and in principle one of the drug makers could earn contest rents. One might expect the payer to set copays to minimize contest rents for the drug makers because contest rents come at the expense of payer profit. This is indeed the case: as the result below shows, the payer sets copays to ensure contest rents are zero for each drug maker, and this turns out to mean c_H is set higher than $\bar{p}_1$ but less than $\bar{p}_2$.

The fact that the payer sets copays to eliminate contest rents simplifies the analysis of the drug makers' choice of list price: they set list prices to maximize their default payoff. Given that $c_H > \bar{p}_1$, drug maker 1's default payoff is $q(\bar{p}_1)\bar{p}_1/2$. This is simply its monopoly profit at price $\bar{p}_1$, and is maximized at $\bar{p}_1 = 1/2$. Drug maker 2's default payoff is $q(c_H^*)\bar{p}_2/2$, where c_H^* is the intermediary's optimal choice of high copay given list prices. Drug maker 2's default payoff turns out to be increasing in $\bar{p}_2$, and so is maximized at the upper end of its choice set, $\bar{p}_2 = 1$. Neither drug maker earns contest rents, but drug maker 2 has the higher default payoff and so enjoys higher equilibrium profit.

The following result formalizes this intuition:

Proposition 5 (**High equilibrium list price when list prices are endogenous**). *Suppose drug demand is linear. Without loss of generality let $\bar{p}_1 \leq \bar{p}_2$. Then, in the endogenous list price model, the unique subgame-perfect Nash equilibrium list prices are $\bar{p}_1^* = 1/2$ (the monopoly price) and $\bar{p}_2^* = 1$ (the maximum possible price). Drug maker 2 earns higher profit than drug maker 1, and combined drug maker profit is higher and the formulary's profit is higher than when list prices are exogenously fixed at the monopoly level.*

It may not seem surprising that one of the list prices is set to the monopoly level, since the drug maker's payoff is tied to revenues in the non-preferred tier, which is maximized at the monopoly list price. But the extremely high value for the other list price is a surprising result: demand at that price is zero, so no transactions actually occur at that price. Instead, the extremely high list price on the part of one drug maker is a response to the biased formulary incentives that tilt the contest in favor of the drug with the higher list price. One drug company sets a list price as high as possible, while the other chooses the monopoly level.[18]

Figure 4 depicts the list price equilibrium graphically. The figure plots each drug maker's best response list price as a function of the other's list price. The blue

[18]This outcome follows from the incentives in of our model, but industry observers note closely related pricing incentives. For example Feldman (2020, p. 327) comments that drug makers have an incentive to offer high list prices because this allows the PBM to offer their clients what appears to be a more attractive discount

points show that when drug maker 1 sets a low enough list price, drug maker 2 will optimally set its list price as high as possible. When drug maker 1's list price is high, however, drug maker 2 optimally sets its list price to the monopoly level (one-half). The figure shows two equilibria where the best response functions intersect: one where drug maker 2 sets $\bar{p}_2 = 1$ and drug maker 1 sets $\bar{p}_1 = 1/2$ and another where they are reversed.

8 Common Agency and Vertical Integration

Our analysis so far takes a rosy view of the problem of aligning the interests of PBMs and payers. Formularies, we argue, enable "near" efficient pharmaceutical markets that benefit formulary operators. Contracting externalities reduce these benefits when numerous payers operate their own formularies, but near efficiency can be restored when payers delegate the operation of formularies to a single PBM acting as a common agent.

Because PBMs in our model capture the joint surplus produced by themselves and payers, there is an easy alignment of interests between principal and agent. This simplifies the analysis, but at the cost of downplaying the possibility that the PBM may take actions that are not in the interest of payers. For example, suppose that contrary to our prior analysis, PBMs do not have full information about the demand for drugs within each payer's population. This information asymmetry prevents the PBM from capturing all the joint surplus and breaks the alignment between PBMs and payers. To illustrate the issues created by asymmetric information, consider a PBM decision that we did not include in our baseline model. Payers would prefer if the PBM promoted generics so that they could offer their members lower-priced formulary services. The surplus resulting from these lower cost services, however, need not flow to the PBM.[19]

[19]Similar problems can arise within the market for branded drugs. Feldman (2020) describes how the use of volume-based rebates for individual drugs or bundled rebates for groups of drugs can induce PBMs to exclude less expensive or more clinically desirable drugs from a favored formulary position. Here again, payers would benefit if the PBM promoted the less expensive or clinically desirable drug, but these benefits needn't flow to the PBM.

One way to resolve this agency problem is through a contract. We have already reported that contracts between PBMs and payers include penalties if the *aggregate* use of generics falls below some pre-specified threshold. Aggregate caps are, however, a crude instrument for promoting the use of generics. In a conventional principal agent setting, a payer could motivate the PBM to do more by writing a shared savings incentive contract with the PBM. Under common agency, however, such agreements may not be workable. To see this consider that when a PBM invests in the software and information systems that improve generic substitution, this will likely enable more generic usage by all its payer clients. This externality leads to inefficiently weak equilibrium incentives. Indeed, if investments in generic substitution involve substantial fixed costs, the equilibrium can be one in which no payers will write any incentive contracts at all (Frandsen et al., 2019).

Vertical mergers between PBMs and payers may reduce or eliminate the contracting inefficiencies resulting from common agency. The merged entity's profits will include the value created by enhanced use of generics. As the stock of generic drugs grows, the benefits of substitution likely increase, and so PBMs will come under increasing pressure to integrate vertically. Consistent with this logic, in the past several years, large PBMs have vertically consolidated with substantial insurers, including UnitedHealth Plans (health plan) with OptumRx (PBM), Aetna (health plan) with CVSCaremark (PBM), and many Blue Cross Blue Shield plans (health plan) with PrimeTherapeutics (PBM).

In justifying vertical integration between PBMs and payers, the business press often emphasizes the returns to better integrating the information held separately by PBMs and payers. For example, in the press release announcing the final merger of CVS with Aetna, the CVS Health President and CEO, Larry Merlo, is quoted as saying,

> By fully integrating Aetna's medical information and analytics with CVS Health's pharmacy data, we can develop new ways to engage consumers in their total health and wellness through personal contacts and deeper collaboration with their primary care physicians. As a result, we expect patients will benefit from earlier interventions and better-connected

> care, leading to improved health outcomes and low medical costs. (CVS Health, 2018)

Recent research finds that the incentives to integrate information systems are also influenced by the limits that common agency imposes on incentive contracts (Frandsen et al., 2019, Section 5). To see this, consider that both CVS and Aetna likely benefit from having sole control over their own information systems, but information sharing becomes more efficient when they sacrifice some of this autonomy and operate their systems in close concert. As separate organizations, the weak incentives induced by common agency may provide inadequate compensation for giving up this autonomy. Under integrated governance, however, these distortions are removed, and incentives for maximizing the value created by integrated information systems increase. In this way, common agency creates a complementarity between vertically integrated governance structures and integrating information systems.

9 Conclusion

Pharmacy benefit managers (PBMs) dominate the market for branded pharmaceuticals in the United States. Our analysis offers insights into otherwise puzzling questions about the economics of PBMs. First, why do drug makers pay rebates to PBMs? Rebates are drug maker bids in an all-pay contest for placement in preferred formulary tiers. The additional surplus generated by these tournaments accrues as rents to the PBM rather than to consumers or pharmaceutical manufacturers. This result suggests that the challenges PBMs pose for economic policy have more to do with distribution than static efficiency.

Secondly, why do payers delegate the crucial and potentially profitable formulary function to an independent actor and why do large PBMs acting as a common agent for many other payers dominate the market? Payers delegate because a common agent PBM is better able to internalize the contracting externality created by most favored nation arrangements. By internalizing this externality, large PBMs can deliver lower net drug prices and improved market efficiency.

Third, what role do high list prices play in a pharmaceutical market where relatively few transactions actually take place at list price? Because drugs can be purchased outside of the formulary at list price, high list prices increase the value of participating in the PBM's formulary. If PBMs can capture this surplus, they may bias formulary contests in favor of drugs with high list prices. In equilibrium, some drug makers will set list prices at the monopoly price while others will choose much higher list prices. The net result is an increase in joint surplus for drug makers and PBMs, but consumers are worse off and markets become less efficient.

Our framework may have implications for efforts to reform and regulate the U.S. market for prescription drugs. Some reform proposals focus on altering who receives rebates from drug makers or propose eliminating them entirely.[20] Our analysis suggests that such an approach may prove disappointing. In our baseline model, passing rebates through to payers or consumers, for example, would not improve the efficiency of formularies or alter the distribution of economic benefits. This is because payers would respond to such a transfer by raising their premiums and PBMs would respond to payers' higher premiums by increasing the reimbursement prices they charge payers. A richer model that allows for more consumer heterogeneity may produce a less stark distributional result, but our findings are sufficient to suggest caution about the ultimate distributional effects of altering which party in this complex market gets rebates.

Efforts to eliminate rebates altogether are similarly likely to have negative effects because the all-pay contest that reduces the net price of pharmaceuticals cannot operate without rebates or their equivalent. Some observers have noted that the secrecy surrounding net prices puts payers and consumers at a disadvantage relative to PBMs and should, therefore, be eliminated (Feldman, 2020). Our analysis suggests a slightly different approach. A well functioning formulary requires that the rebates offered on any given drug be kept secret—otherwise the competition driving the desirable consequences of the all-pay contest would stop. There is, however, no

[20]The Trump Administration in Fall 2020 finalized an administrative rule that would require rebates paid to PBMs by branded drug makers to be passed through to consumers (Department of Health and Human Services, 2020).

equivalent economic rationale for keeping the total rebates received by the PBM across all drugs and drug makers a secret.

Other approaches to reform are motivated by the enormous market power accumulated by large PBMs and recommend creating greater competition between a larger number of smaller PBMs (Garthwaite and Scott Morton, 2017). Our analysis does not explicitly model competition between PBMs, but it suggests that some pro-competitive reforms will be more effective than others. Breaking up PBMs without eliminating the contracting externality resulting from most favored nation arrangements may directly reduce market efficiency and increase drug prices. Eliminating most favored nation arrangements, however, will reduce the efficiency advantages enjoyed by large PBMs and so make the PBM market more competitive in a way that benefits consumers.

The mergers of large PBMs and large payers also raise questions for competition policy. Our analysis suggests that under common agency, vertical integration creates value because it can mitigate contracting and coordination problems between a PBM and payers. It is, of course, also possible that vertical integration between large PBMs and large payers has anti-competitive effects that lie outside of our model. Understanding any potentially anti-competitive consequences of vertical integration and how these may interact with the efficiency enhancing consequences is an important area for future research.

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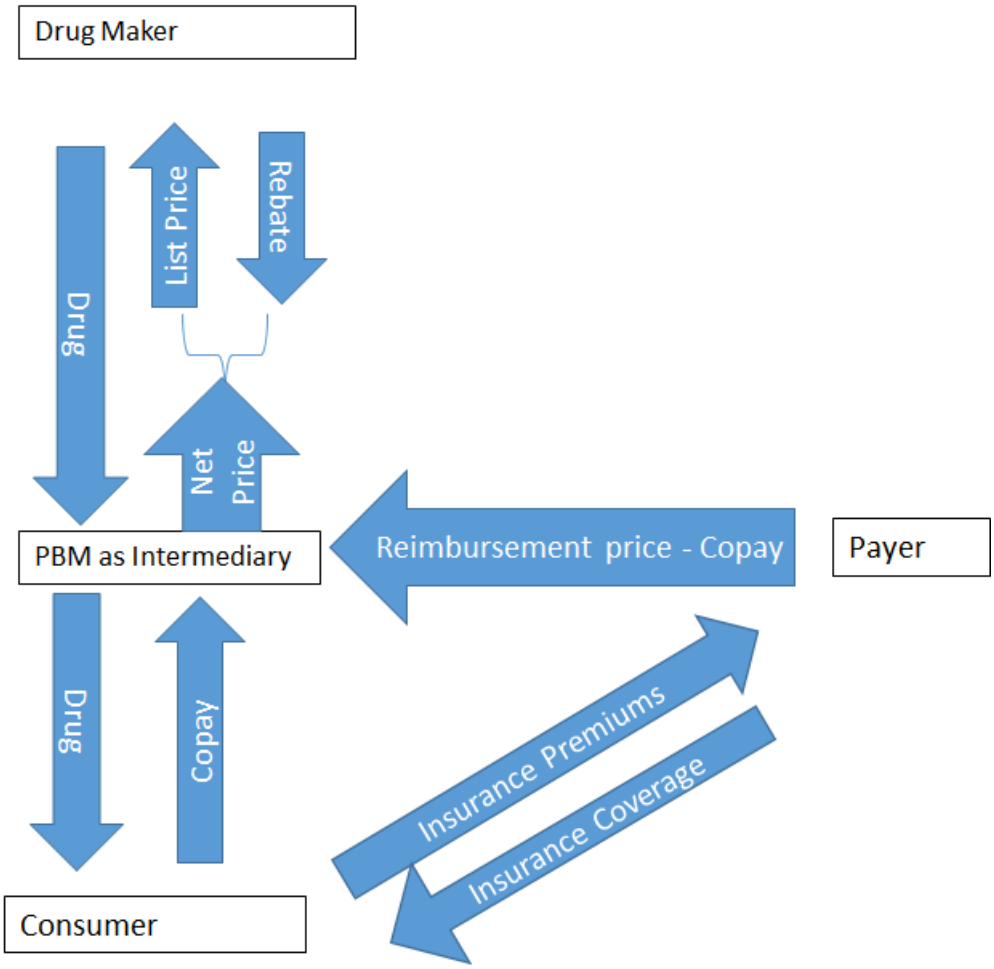

Figure 1: PBM as Intermediary Between Drug Makers, Payers and Consumers

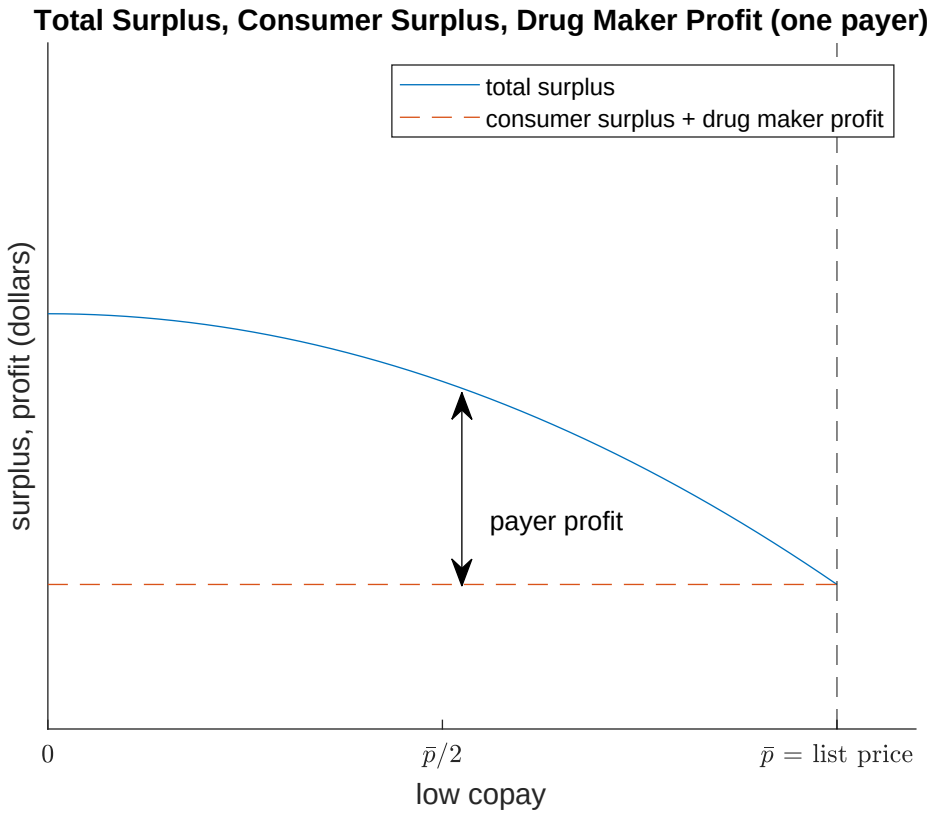

Figure 2: Total surplus and combined consumer surplus and drug maker profit as a function of the copay in the preferred tier. High copay set at the list price, $\bar{p}$.

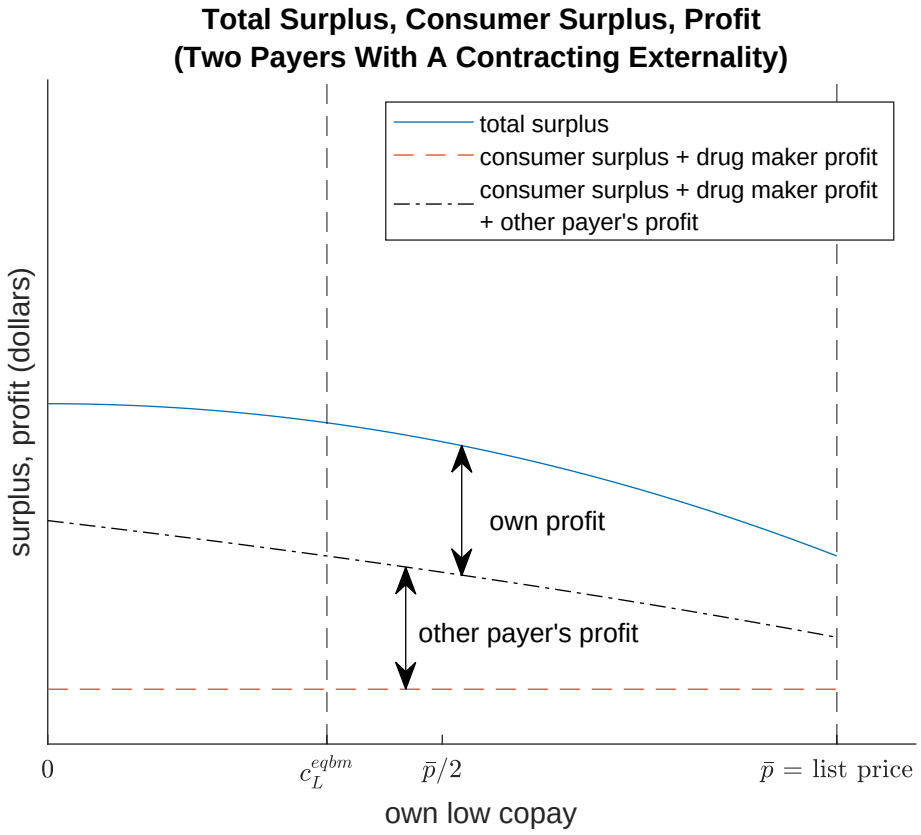

Figure 3: Total surplus and combined consumer surplus, drug maker profit, and other payer's profit as a function of one payer's own copay in the preferred tier. Copay in the non-preferred tier set at the list price, $\bar{p}$, and other payer's copay set at the equilibrium value.

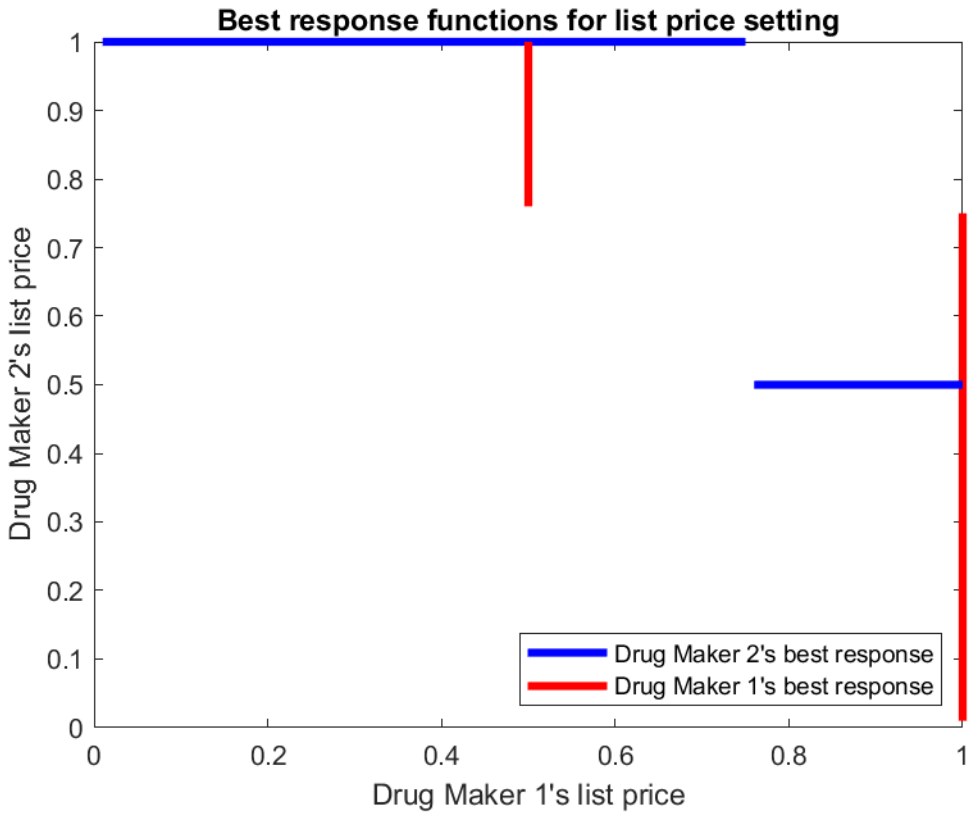

Figure 4: Best response function for one drug maker's list price as a function of the other drug maker's list price.