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The Value of Pharmacy Benefit Management

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ABSTRACT

In theory, equilibrium profits for drug patent holders would not involve significant restraints on production and patient utilization if the market had a mechanism for two-part pricing (Oi 1971) or quantity commitments (Murphy, Snyder, and Topel 2014). In fact, patent expiration has little effect on drug utilization especially when those drugs are delivered through insurance plans. This paper provides a quantitative model consistent with the theory and evidence in which pharmacy benefit management on behalf of insurance plans serves these and other purposes in both monopoly and oligopoly provider settings. Calibrating the model to the U.S. market, I conclude that pharmacy benefit management is worth at least \$145 billion annually beyond its resource costs. PBM services add at least \$192 billion annually in value to society compared to a manufacturer price-control regime. Requiring all PBM services to be self-provided by plan sponsors would forgo about 40 percent of the net value of PBM services largely by increasing management costs. Due to changes in the incidence of PBM services over the drug life cycle, the services encourage innovation even though they reduce the profits of incumbent manufacturers.

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I. Introduction

Prescription drugs have reduced mortality and morbidity from heart disease, cancer, infectious disease, and many other health conditions.¹ The U.S. market size is approaching \$500 billion annually, with about two-thirds of adults using them and almost 300 million people participating in prescription-drug insurance plans. With the market so profoundly affected by public policy, it is essential to understand its structure, conduct and performance.

A fundamental fact is that even cost-effective new drugs are expensive to develop (Lichtenberg 2019), which drives a demand for third-party financing, both of which can distort drug utilization. Drugs may be underutilized because of high marginal costs to the patient, lack of patient knowledge, or the moral hazard involved with preventing conditions whose medical expenses are themselves covered by insurance.² Moral hazard may also result in drug misuse and health harms, as it did with opioid prescriptions (Council of Economic Advisers April 2019), or in fraud and improper payments.

Drug insurance plan sponsors understand that it is wasteful – resulting in premiums that are too high to attract members – to have third-party payment and leave the benefit unmanaged. Pharmacy benefit management services (PBM services) is the industry term for the management of patient utilization, processing of prescription drug claims, and negotiating plan savings from other actors in the healthcare supply chain. The services include plan design features such as allocating drugs to different copay tiers or requiring plan authorization prior to patient access, drug utilization reviews that help improve drug effectiveness and prevent adverse drug reactions, obtaining rebates and discounts from those providers whose sales are increased by the plan, and managing specialty drugs. PBM services thereby expand the economic pie in prescription markets.

PBM services also redistribute from manufacturers and pharmacies to consumers as negotiations and plan design fuel competition that lowers retail and manufacturing prices. PBMs ultimately, if not intentionally, encourage drug innovation by increasing utilization early in the patent life where sales are most important in terms of creating a financial return to developing

¹ Lichtenberg (2019, 2003, 2007).

² Moral hazard refers to the distorted incentives that come with “spending other people’s money” (Klick and Stratmann 2007). Government regulation can also be a barrier to patient utilization, but I hold regulation constant for the purpose of assessing the value of pharmacy benefit management.

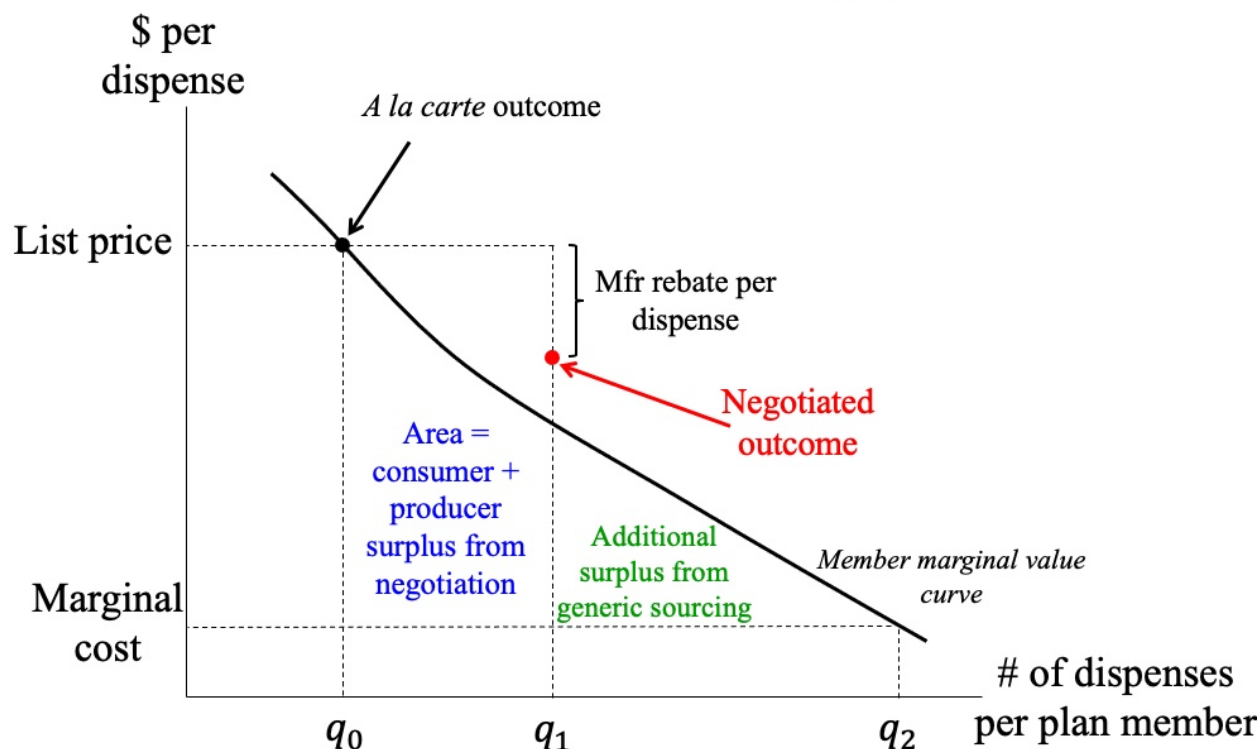
new drugs. By saving governments money and thereby limiting their need to increase distortionary taxes, PBM services also benefit the wider economy.

The purpose of this paper is to quantify the value of PBM services in a framework that permits analysis of scenarios that involve regulatory or tax constraints on PBM services. I refer to “a PBM” or “PBMs” as a business or businesses that specialize(s) in providing PBM services to health insurance plans. The value of PBM services is estimated relative to three baselines. The first is a baseline of no services to manage utilization, meaning that plans compete to (a) purchase drugs directly from manufacturers and retail services directly from pharmacies at the same price that the uninsured do, (b) set premiums and copays for patients, and (c) leave to patients and their physicians to decide whether and how much of a drug to purchase. The second baseline has utilization and claim-processing services, but they are all provided “in house” by each plan rather than by specialized PBMs. The third baseline has utilization managed indirectly through government-enforced price controls. I estimate the annual value to society of PBM services to be at least \$145 billion beyond its resource costs relative to the first baseline and \$192 billion relative to the price-control regime. Requiring all PBM services to be self-provided by plan sponsors would preserve about 60 percent of the net value of PBM services but forgo the other 40 percent largely by increasing the cost of providing PBM services. The value to society includes not only consumer savings net of manufacturer losses, but the values of better drug utilization, an increased pace of drug development, and government savings.

From the perspective of consumer demand, the first potential source of underutilization is the gap between list price and the marginal cost of producing, delivering, and administering the drug. This source is especially relevant for newer branded drugs that are still under patent and thereby available only from a single manufacturer, although other manufacturers may sell chemically different drugs that treat the same condition. Economics has long noted that such gaps open opportunities for mutually advantageous trade between seller and buyers where the buyers receive a discount for purchasing more than they would at list price (Oi 1971, Telser 1994, Lakdawalla and Sood 2013). PBMs arrange such trades by obtaining manufacturer rebates in exchange for placement in the plan’s benefit structure that helps the manufacturer make additional sales to plan members. Figure 1 illustrates the joint value of manufacturer-rebate transactions as the area under the consumer (i.e., patient) demand curve between q_0 – the

quantity that would be purchased without rebates – and q_1 , which is the quantity expected to result from the favorable plan placement.

**Figure 1. Valuing Benefit Management
on the manufacturer side of the supply chain**



The marginal value curve holds constant prices of substitutes and complements that would be sourced generic even without benefit management.

Section III of this paper examines and estimates the various costs and benefits to patients, plans, and manufacturers who are parties to the PBM trade agreements. Section IV discusses “external effects” of PBM services on the rest of the economy, especially effects on drug innovation and on labor and capital markets as PBM drug savings make room for lower taxes or additional spending on other public programs. Table 1 provides a preview of those results. One finding is that \$99 billion in manufacturer rebate transactions in 2020 benefited patients and plans \$51 billion more than they cost manufacturers, as shown in Table 1.³

³ Supporting materials in Excel and Mathematica format are hosted with this paper at nber.org. The cited \$51 billion does not yet subtract the resource costs of PBM services, which are discussed below and appear on a separate row of Table 1.

Table 1. The Role of Benefit Management in Creating Value in the Pharmaceutical Industry and Beyond

PBM Activity	Incremental value added, \$ billions/year
Baseline: No PBM services	0
Manufacturer rebates tied to plan design	51
Promote generics	16
Pharmacy rebates tied to plan design	5
Provision of mail pharmacy	3
Plans' nonpharmacy medical benefit from added utilization	40
External effects: reduced tax distortions	47
External effects: accelerated pace of drug innovation	6
Prevent medication errors	Not quantified
Seamless technology interface	Not quantified
Fraud prevention	Not quantified
Total quantified benefits, \$ billion/year	168
SUBTRACT: Resources used by PBMs	22
Total quantified value creation, net of PBM resources	145
Addenda	
Quantified value added in the supply chain, net of PBM resources	92
Quantified plan benefits net of PBM expenses	240

Note: benefits in the supply chain reflect reduced profits for manufacturers and pharmacies, whereas plan benefits do not.

Source: Tables 3-5.

I also estimate that, while actual rebates significantly increase utilization, they typically are not large enough to incent plans to provide the brand versions to patients as cheaply as generic drugs. Therefore, PBMs can further encourage appropriate utilization and adherence (hereafter, “utilization”) by facilitating switches to cheaper generics when they become available. Of course, generics offer potentially large savings to plans, but the additional utilization means that the loss to brand manufacturers is less than the gain to plans by the amount shown in Figure 1 between q_1 and q_2 . Although generics would exist even without PBM services, I estimate that 15 percent of drugs dispensed are generic because of PBM services, generating a joint value of about \$16 billion.

The facts that brick-and-mortar chain and big-box pharmacies account for the majority of pharmacy-industry revenue and offer discounts to PBMs in exchange for favorable placement in plan pharmacy networks suggest that a calculus analogous to Figure 1 also applies at the retail end of the supply chain. PBMs also provide something akin to generic retailing, which is mail-order pharmacy.⁴ By assuming that the utilization and incidence effects of discounting are in the same proportion to the dollar amount of discounts (or rebates) at both the manufacturer and retailing ends, I estimate that PBMs' pharmacy activities generated about \$8 billion in joint value, more than 100 percent of which accrued to plans. Together, these four methods of increasing utilization generated a combined net value in 2020 of \$75 billion for patients, plans, manufacturers, and pharmacies.

Proper drug utilization can prevent more serious illnesses and the more expensive healthcare associated with them. Much of this savings is reflected in the patient's demand for drugs, and therefore in the \$75 billion in annual value cited above. However, because plan members are typically insured for hospitalization and other nondrug health spending, a plan can add value by especially encouraging proper utilization of drugs that help prevent future claims. I estimate this additional value to be about \$40 billion in 2020.

PBM services also have effects outside the supply chain. By reducing health insurance premiums, PBM services save taxpayer money both by reducing premium subsidies and premium tax expenditures. Although PBMs squeezes manufacturer profits on average and a PBM is a distinct business from drug research, it ultimately helps increase utilization and thereby profits early in the patent life where it counts most toward the financial return to drug development. I estimate that these two external benefits are \$47 billion and \$6 billion annually, respectively.

Altogether, I estimate the annual combined value of the various PBM tools to be \$145 billion, which nets out the PBM resource costs of \$22 billion.⁵ The net value to society reflects a \$240 billion net benefit for plans and their members, \$148 billion of reduced profits for manufacturers and pharmacies, and \$53 billion of external effects. In other words, PBM services

⁴ PBMs may brand their mail order pharmacies but have good incentives to provide the retailing and delivery services close to marginal cost, which is the key economic characteristic of a generic product.

⁵ As part of their participation in the trade agreements, PBMs receive fees which go toward employee salaries, profits, and other expenses. I estimate \$22 billion by multiplying an estimated \$374 billion net (of rebate) drug spend for 2020 by Sood, Shih, et al.'s (2017) estimate of the percentage (six) of net drug spend that goes toward PBM costs and profits.

expand the economic pie in prescription markets while redistributing from manufacturers and pharmacies to consumers as PBM negotiations fuel competition that lowers retail and manufacturing prices.

II. PBMs pass the market test

Insurance plans are not required to retain PBMs or even to perform PBM services themselves beyond processing prescription claims. They could pay manufacturers and pharmacies their list prices for all pharmaceutical products and retail services, without any of the expense of PBM services, but they choose not to. 95 percent of all scripts at retail pharmacies involve a PBM. 91 percent of drug-plan participants are served by PBMs. Plans understand that it is wasteful – resulting in premiums that are too high to attract members – to have third-party payment and leave the benefit unmanaged.

Likewise, manufacturers and pharmacies could insist on making all sales at list price and leave to plans and members to decide how they allocate their expenditures among competing providers. The prevalence of PBMs itself suggests that it is each manufacturer's and pharmacy's unilateral interest to negotiate with plans, even while each might prefer that others did not compete so vigorously for consumer business.⁶

PBM services are provided in a competitive market, which means that plans have a choice of how benefits are managed and that successful PBMs must be attentive to the effects of their management methods on plans and ultimately patients. As of 2021, 70 companies offered a full range of PBM services in the U.S. market. The PBM market has the additional, and somewhat unusual, source of potential competition in that the larger customers (insurance plans) themselves were once the suppliers and could do so again. Indeed, the health insurer Anthem recently launched its own PBM to both service its claims and offer its services to other insurers, at least one of which (Humana) had its own PBM (Tepper 2021). The Purchaser Business Group on Health, a coalition of large employers originally in San Francisco and northern California, has

⁶ Although the prescription drug market is heavily regulated and subsidized, PBMs do not exist or thrive as a scheme to extract additional public funds or to circumvent government rules. As major plan sponsors, governments and ultimately taxpayers benefit significantly from the savings that PBMs deliver for plans (Section IV of this report).

also started a PBM (Kacik 2021). The three largest PBMs (CVS Caremark, Express Scripts, and Optum Rx) are already vertically integrated with insurers.

Many PBMs began as internal pharmacy departments of large health-insurance plans, where they “learned how to successfully manage their own pharmacy programs....” As plan drug spending accelerated in the 1980s, the plans “formed subsidiary or stand-alone PBM units and began offering their pharmacy management skills to other health plans.” Two other PBMs began as independent companies that provided services directly to large employers. By 1994, most of the PBM market was owned by drug manufacturers, but subsequent regulation may have encouraged them to have independent ownership or partner with other companies in the supply chain.⁷ This history accords with the economic prediction that plans want their drug benefit managed while manufacturers also see PBM services as a vehicle for increasing sales. The history also suggests that, while the larger plans could manage their own benefit, even they see cost savings from PBM services on a scale larger than a single plan.

III. Sources of Value

The market success of PBM services is one indicator of its value to plans if not to manufacturers and pharmacies. Other indicators come from the services themselves, which are consistently oriented toward more appropriate utilization and reduced management costs. Rebates and discounts from manufacturers and pharmacies help reduce plan premiums and are granted in exchange for plan designs with greater patient incentives to utilize the manufacturer or pharmacy providing the rebate or discount. Sourcing from generics, when available, further reduces premiums by reducing plan costs and further reducing patient copays. Mail pharmacies, many of which are sponsored by PBMs, can reduce patient costs and increase patient convenience, both of which encourage utilization (Duru, et al. 2010, King, et al. 2018). Health plans benefit from better drug utilization from reduced nonpharmacy medical expenses, such as complications from diabetes or heart disease.

⁷ The quotes and history cited in this paragraph are from Navarro (1999, p. 34).

III.A. Paying Less for Prescriptions: the Value of Group Drug Purchasing

PBMs are a procompetitive force in healthcare markets, where drug manufacturers and retail pharmacies frequently have market power. Some of the manufacturer market power derives from pharmaceutical patents. In the retail pharmacy market (excluding mail pharmacies), the top three retailers have 60 percent of the market.⁸

Perhaps public policy changes could increase competition among drug manufacturers and among retail pharmacies. But until that happens, competition can still be enhanced by group purchasing and negotiated discounts. PBMs do exactly that, in some of the same ways that Costco, Sam's Club, and other buyers' clubs obtain manufacturer discounts on behalf of their members.⁹

To further appreciate group purchasing is more than a zero-sum game (benefits the purchasers more than it reduces seller profits), it helps to recall how sellers exercise market power: by restricting the quantity that they sell. A seller would like to raise its price – charge more – but cannot do so without restricting quantity. The Organization of Petroleum Exporting Countries (OPEC) is perhaps the most famous sellers' cartel. OPEC exercises its market power by limiting the oil production of each of its members. Healthcare providers do that too (U.S. Department of Health and Human Services 2018). Exercising market power delivers more profits when the sellers face a demand curve that is less price sensitive, so that small reductions in quantity can sustain large price increases.

Buyers' clubs induce sellers to limit their exercise of market power by presenting them with a more price-elastic demand curve (Jaffe, et al. 2019). The members of Costco may not have a particularly price-elastic demand for particular brands of, say, skateboards. Skateboard manufacturers know this and hike their prices when dealing with consumers individually. But Costco limits the number of manufacturers who can sell to their members to one or two manufacturers pricing the lowest. In effect, each manufacturer bidding to be in Costco faces a very price-elastic demand from the club because a small increase in price will cost her all of her sales through Costco. With a low price of skateboards in the store, Costco members buy more

⁸ A full assessment of retail-pharmacy competition would, as with the PBM services themselves, consider the potential for plans to enter the market as a supplier. None of the top nine retail drugstores/supermarket pharmacy companies were launched by health insurers, although historically some large plans maintained their own pharmacies (Fein 2022).

⁹ Costco is a buyers' club for a range of consumer products, including prescription drugs. Specifically, Costco owns the PBM Costco Health Solutions and is a partial owner of another PBM (Navitus).

skateboards than they would if there were no buyers' clubs in that market. Quantity discounts obtained by buyers' clubs serve much the same purpose (Murphy, Snyder and Topel 2014). Either way, lower prices and higher quantities are the proof that buyers' clubs are procompetitive.

In much the same way that Costco excludes skateboard manufacturers and restaurants exclude soda vendors, PBMs can exclude manufacturers, or place a manufacturer's products less favorably in the plan, to incentivize the favored manufacturers to deliver drugs to plan members at a lower price. As Patricia M. Danzon put it, "[t]he basic principle is that PBMs can drive discounts on drug prices and pharmacy fees by restricting patients' choice of drugs or pharmacies, thereby increasing volume for preferred suppliers that accept the discounted prices. Thus, more restrictive drug formularies or pharmacy networks generally obtain larger discounts" (Danzon 2015, p. 246).

Just as Costco membership has little relation to skateboard-brand preference, or restaurant choice little relation with soda-brand preference, working for a business (employers are the most common sponsor of prescription-drug plans) has at most a weak relation with the demand for prescription drugs. The diversity of the group is what allows the group purchasing to deliver so much value. If all of the patrons of a restaurant strongly preferred Coca-Cola, Coca-Cola would have little reason to offer the restaurant a discount for an exclusive position on its menu knowing that customer demand alone would sustain that position.¹⁰

Sheer size of a buyers' club can also push prices lower, but the sheer size effect is anticompetitive because a buyers' club dominating the market restricts the amount that it purchases in order to squeeze a lower price out of the sellers. Lower prices and lower quantities are proof that the practices of a dominant buyer are anticompetitive.¹¹ This "monopsony" approach to purchasing healthcare is taken by "single-payer" countries, which restrict the quantity of healthcare by withholding treatments from particular demographic groups or having a narrower range of available drugs (Council of Economic Advisers March 2019). Results of

¹⁰ In the context of health insurance, a diverse group also helps reduce the costs of "adverse risk selection," which in extreme circumstances can leave a large fraction of the population uninsured (Hackmann, Kolstad and Kowalski 2015, Bundorf, Levin and Mahoney 2012).

¹¹ Restaurant purchases of soda are an example of how buyers' clubs can be effective even on a small scale. Restaurants, any one of which has purchases that are a tiny fraction of the overall soda market, typically tell Coca-Cola and PepsiCo that only one of the companies' products will be served in the restaurant, to be determined by which offers the lowest price (Klein and Murphy 2008). The result is sometimes a discount that is so significant that the restaurant provides consumers "free refills" (i.e., a large quantity of soda).

monopsony in healthcare markets include shorter survival times for cancer, and fewer intensive beds available during the COVID-19 pandemic.¹²

At first glance, the direction of the quantity effect of negotiations with manufacturers by restaurants, Costco, or PBMs might appear ambiguous because, akin to the monopsony approach, the ultimate customer may have less choice albeit at a lower price. It is important to recognize that no single PBM is a monopsonist (the only buyer of a drug). While the plans served by the PBM might be willing to reduce prescriptions in exchange for a lower price, individual plan members are (with a physician's prescription) capable of making drug purchases at list price outside the plan. A PBM loses bargaining power when its formulary restrictions excessively burden a segment of its members because the manufacturer expects it may reach those members outside their plans. In other words, the existence of other PBMs as well as individuals capable of purchasing on their own incentivizes PBMs to use management tools that create value rather than redistributing it.

Four important types of evidence indicate that PBM services increase utilization rather than reducing it. One is a study of drug-patent expirations by Lakdawalla and Sood (2013) showing how the quantities sold under patent are further below the post-patent quantities when the potential drug consumers are less likely to have prescription-drug coverage and thereby be served by a PBM. In terms of my Figure 1, their results suggest that $q_0 < q_1 < q_2$.¹³ A related finding is that patent expiration does little to increase market-level sales (Lakdawalla and Philipson 2012), which further suggests that q_1 is well above q_0 and close to q_2 and further supports my conclusion that PBM services significantly increase utilization even when generics are not available.

A second comparison is with the uninsured. Of course, the uninsured population is different from the insured, but studies of changes in drug coverage for a given population find that insurance coverage by itself increases drug utilization (Lichtenberg 2007, Kaestner, Schiman and Alexander 2019), which in terms of Figure 1 suggests that $q_0 < q_1$. Third, several studies show that mail-order pharmacies, an important service provided by PBMs, by themselves

¹² See Philipson et al (2012) on cancer survival times. Rhodes et al (2012) measures per-capita intensive care beds around the world. The lowest four are all single-payer countries.

¹³ In other words, the high utilization rates prior to patent expiration belie assertions that rebate negotiations are anticompetitive, because anticompetitive practices by definition reduce utilization. Discussion of utilization rates is conspicuously absent from, e.g., the Department of Health and Human Services claim that “rebates ... prevent[] competition to lower drug prices...” (84 FR 2343).

increase medication adherence. The fourth comparison is the rebates received from manufacturers facing more therapeutic competition from those facing less, which I discuss further in Section IV.B.

Assuming a functional form for the demand curve and that marginal cost is constant, an estimate of the quantity effect $q_1 - q_0$, and therefore the surplus area in Figure 1, can be derived from estimates of four parameters. Three of those parameters are rebates as a share $r > 0$ of list price, the price elasticity of demand $\varepsilon < 0$ facing the typical manufacturer, and the share β of bargaining surplus going to buyer rather than seller. The fourth parameter is the share of the bargained quantity that expands the market rather than coming from competitors, which is essentially the ratio $\eta/\varepsilon < 1$ of the segment-level demand elasticity to the firm-level elasticity.¹⁴

My assumptions, estimates and their sources are shown in Table 2. Perhaps the most important estimate shown in the table is that the average branded list price is a factor of six above what it would be in a generic market. Without efforts to manage the benefit or otherwise promote sales, utilization of the drugs would be depressed by a factor of two or more. PBMs can and do alleviate this distortion both by changing plan placement and encouraging plan participation (and participation in more comprehensive plans) through the lower premiums made possible by negotiating prices below list price.

¹⁴ The segment refers to the set of drugs where PBM services may affect acquisition price or plan placement, and therefore excludes the many dispenses that would be sourced generic with low copays even without PBM services. The segment is more price elastic than the Rx market as a whole because the drugs outside the segment include substitutes for drugs inside. The Appendix shows more precisely how one seller's price change affects competitors' sales and how that relates to the parameters η and ε .

Table 2. Industry parameters

for the segment of prescription drugs with significant brand sales

Parameter	Value	Description
Manufacturer rebates		
Avg. % of List Price	30%	Visante (2020) "rebates for brand-name drugs."
\$ billions annually	99	2016 industry rebates of \$89 billion (Altarum 2018), rescaled to 2020 with gross drug spend.
Pharmacy rebates (DIR), \$ billion/yr	9	2019 industry rebates (Fein 2020), rescaled to 2020 with gross drug spend.
Price elasticity of demand		
Firm level	-1.2	Based on branded list-price markup factor of 6 over marginal cost (Caves et al).
Segment level	-0.5	Assumed between firm-level and class-level elasticity (Einav et al 2018 estimate for class level is about -0.3)
Firm quantity changes reflected at the segment level	42%	Ratio of segment-level to firm-level price elasticities.
Bargaining surplus going to provider		Assumed split is the midpoint of range consistent with observed rebate rate.

The top of Table 3 shows my estimates of the effect of PBMs' negotiations with manufacturers of branded drugs, where PBMs offer favorable placement in drug plans in exchange for rebates. Because the estimates depend somewhat on the unmeasured distribution of patient willingness to pay below manufacturer list price (that is, the shape of the market demand curve in that range), the table shows both linear-demand and constant-elasticity demand scenarios.¹⁵ Because rebates average 30 percent of gross brand drug spend, I estimate that brand utilization is increased by an average of 34-48 percent by such negotiations, accounting for the fact that each manufacturer gains sales by offering rebates but loses sales from competitors' rebate arrangements. This increased utilization represents a combination of better adherence, utilization of additional prescription products, and additional participation in prescription-drug plans. The aggregate combined dollar value of the increased utilization is 47-57 percent of the aggregate rebate amount (second panel of Table 3). With \$99 billion in rebates in 2020, that makes a combined value of \$46 billion to \$56 billion (third panel).

¹⁵ The demand-system algebra linking Table 2's parameters to Table 3's results is provided in the Appendix. Each Table 1 entry corresponding to a row in Table 3 are the average of the "linear" and "constant elasticity" columns.

Table 3. Demand-model results

For the Rx effects of optimizing rebated brands and generics in plan design

	Demand-curve shape	
	Linear	Constant elasticity
<i>Bargain vs. List price</i>		
Quantity impact	34%	48%
Plan and mfr benefit per rebate \$		
Plans and patients	141%	124%
Manufacturers	-95%	-68%
Total	47%	57%
Plan and mfr annual benefit in \$ billions		
Plans and patients	140	123
Manufacturers	-94	-67
Total	46	56
<i>Generic vs. List price</i>		
Plan and mfr benefit per generic-revenue \$		
Plans and patients	426%	290%
Manufacturers	-353%	-204%
Total	74%	86%

Note: Each column uses the Table 2 parameters, but assumes a different demand-curve shape between list price and marginal cost. The benefits in this table do not net out plans' PBM expenses (Table 1) or count benefits in terms of reduced nonpharmacy medical costs.

Because the rebate transactions are voluntary for both manufacturer and plans, each manufacturer profits from its own transactions although it loses profits when its competitors also offer rebates. I estimate that the net result is \$67 billion to \$94 billion less annual profits for brand manufacturers.¹⁶ Plans benefit \$123 billion to \$140 billion, which is different from the

¹⁶ The profit motive may help explain why drug manufacturers have lobbied the federal government to eliminate manufacturer rebates from “Medicare, Medicaid, other Federal programs, and the commercial market” (Pfizer, Inc. 2019), and why the Congressional Budget Office (2019) estimated that manufacturer profits are reduced by manufacturer rebates. See also Danzon (2015, pp. 258-9). My estimates do not count the positive effect of PBM services on manufacturer profit through the enhanced retail distribution shown in Table 4.

\$99 billion aggregate rebates because plans adjust their benefit design in order to obtain their rebates and PBM services alter the incentives for manufacturers to change their list price.¹⁷ In a competitive market for drug plans, each \$1 billion of plan benefit is ultimately passed onto consumers in terms of reduced premiums and copays.¹⁸

III.B. Paying Less for Prescriptions: Promoting Generic Sourcing

Utilization increases somewhat more when plans can and do source from low-priced generic manufacturers. The final panel of Table 3 expresses estimated benefits from generic sourcing, relative to paying list price, as a ratio to expenditure on generics, assuming for the moment that such sourcing occurs.¹⁹ The total benefit, which comes from increased utilization, is between 74 and 86 percent of the expenditure on those generics. Allocating the combined benefit between manufacturer losses and plan benefits is more sensitive to demand-curve assumptions. I estimate that the plan benefit ranges from 290 percent to 426 percent of generic expenditure, which is large but less than the 500 percent extra that would be paid at list price because of generic pricing.²⁰ The very large benefit for plans means that PBMs either create and implement benefit designs that strongly promote generics or else risk losing plans' business to competing PBMs who will deliver generic savings to plans.

As Danzon (2015, p. 257) describes, "the interests of plan sponsors and PBMs are currently strongly aligned to drive generic substitution and price competition, which has provided large savings for employers/consumers." Ninety percent of U.S. prescriptions dispensed in 2020 were for generics, but presumably many generics would be used even without PBM services because patients would often have a financial incentive to purchase them. I use the European experience with generics to help estimate the contribution of PBM services *per se*

¹⁷ This benefit does not account for plan's cost of compensating PBMs, which is quantified in Table 1.

¹⁸ More than 1,000 plans offer drug coverage to Medicare consumers (Council of Economic Advisers March 2019, p. 422). Even if drug coverage markets were not competitive, plan benefits may still be fully (or more than fully) passed on to consumers, which is known in economics as "over-shifting" (Anderson, De Palma and Kreider 2001).

¹⁹ The practical alternative to generics is likely paying a negotiated price rather than list price. However, the hypothetical negotiation would also be a benefit of PBM services yet is not reflected in the \$99 billion rebate amount that is the basis for Table 3's third panel. Therefore, the additional benefit of PBM services associated with generic sourcing is properly quantified by the comparison between generic price and list price.

²⁰ The consumers who purchase at list price reveal that their willingness to pay is particularly high. In contrast, low generic prices encourage even the comparatively low-value uses. Consumer willingness to pay is Table 3's benefit metric.

to generic sourcing, which then can be combined with the Table 3 results to estimate a dollar value of such activities.

Wouters et al (2017) found U.S. generic dispense rates to be 31 percentage points above those in Europe, where PBM services are much less common. On the other hand, manufacturer entry barriers and government price controls in Europe may also discourage generic sourcing in addition to a lack of PBM services. I therefore assume that half of the U.S.-Europe gap – 15 percentage points (a sixth of total generic drugs dispensed) – is due to PBM services. With annual generic revenue of \$128 billion, this assumption and the results from Table 3 imply additional annual utilization worth \$15 billion to \$17 billion to plans and manufacturers combined, of which \$57 billion to \$84 billion is a benefit for plans and correspondingly less profits for manufacturers. The midpoints of these ranges are shown in Table 4.

Table 4. Additional utilization effects of PBM services

<i>Promotion of Generics</i>	
Percent of scripts dispensed due to PBM services	15%
Quantity impact	22%
Plan and mfr annual benefit in \$ billions	
Plans and patients	71
Manufacturers	-55
Total	16
<i>Negotiations with retail pharmacies</i>	
Quantity impact	0.4%
Plan and pharmacy benefit in \$ billions	
Plans and patients	12.4
Pharmacies	-7.6
Total	4.8
<i>Mail pharmacies</i>	
Quantity impact	0.2%
Plan and pharmacy benefit, \$ billions	3.0
<i>Combined quantity impacts</i>	
Tables 3 and 4	28%

III.C. Paying Less for Prescriptions: the Value of Pharmacy Contracting

Pharmacies are at the retail end of the prescription-drug supply chain. PBM services are also a procompetitive force in retail pharmacies, where it can obtain discounts in exchange for favorable pharmacy placement in plans. To further reduce costs for patients and plans, many PBMs also offer their own mail pharmacy. I estimate that these activities add value of \$8 billion to the industry, more than 100 percent of which accrues to plans as they encourage pharmacy competition.

The economics of the pharmacy part of PBM services is similar to the drug part illustrated in Figure 1. Without PBM services, plans would pay list price to retail pharmacies, which likely is at least somewhat above marginal cost due to the significant market share of a

small number of companies in that market. Pharmacy utilization would be greater, and pharmacy costs less, under a negotiated discount and potentially more so with a cheaper mail pharmacy alternative.²¹ I assume that the pharmacy benefits of PBM services and their allocation are the same ratios to rebates as indicated in Table 3's second panel, except applied to the lesser amount of pharmacy discounts, which were about \$9 billion. This suggests a utilization benefit worth \$5 billion per year, which is the net of a \$12 billion plan benefit and \$8 billion less profit for pharmacies.²² As with the manufacturer rebates, the benefit to plans is less than the rebate or discount because plans offer pharmacies favorable benefit design.

Fein (2022) estimates that 38 percent of prescription-drug revenue goes through mail pharmacies. Assuming that the per-dispense benefit of mail pharmacies is at least the benefit of retail-pharmacy bargains, that puts the annual benefit of PBMs' mail pharmacies at about \$3 billion.

The final row of Table 4 shows a combined utilization effect of PBM services of 28 percent. It includes 41 percent on branded products (Table 3), 22 percent on generics (Table 4), and smaller increases resulting from PBM services at the pharmacy end of the supply chain.

III.D. The Role of Drug Utilization in Reducing Healthcare Claims

Proper drug utilization can prevent more serious illnesses and the more expensive healthcare associated with them. Lichtenberg (2007) finds that each dollar spent on new drugs reduced nonpharmacy health spending by an average of seven dollars. Other studies also find drug utilization to reduce nonpharmacy spending, although in more modest amounts (Kaestner, Schiman and Alexander 2019). Much of the nonpharmacy savings is reflected in the private demand curve for prescription drugs, and therefore in the amounts previously cited based on that curve. However, because plan members are typically insured for hospitalization and other

²¹ Specifically, PBMs negotiate discounts with pharmacies as well as Direct and Indirect Remuneration (DIR) fees. The PBMs front pharmacies funds to conduct drug adherence programs, and then pull funds back (DIR fees) when the pharmacies do not meet the adherence metrics. From the pharmacy perspective, the discounts serve the purpose of attracting customers away from competing pharmacies, which can occur when the PBM includes the pharmacy in its preferred network.

²² Lacking the required pharmacy cost information, my profit estimate does not include the potentially large increase in pharmacy profit resulting from the additional utilization induced by PBM activities on the manufacturing part of the supply chain. PBM helps reduce the "double marginalization" (Spengler 1950) in the prescription-drug supply chain, which is reflected in my quantity estimates but not in my profit estimates.

nonpharmacy health spending, a plan can add value by especially encouraging proper utilization of drugs that help prevent future claims. The case for plan encouragement is especially strong when drug adherence requires significant effort and other nonpecuniary patient costs because, unlike the hospital costs they prevent, such costs are not reimbursed by plans.

Kaestner and Kahn (2012) examined the creation of Medicare Part D (the federal drug coverage program for the elderly), which increased elderly prescription utilization by about 35 percent as compared to the 28 percent I estimate for the general population from PBM services (bottom of Table 4). Rescaling Kaestner, Schiman and Alexander (2019) hospital-spending findings (for the same Medicare episode) to Table 4's quantity impact, that means reduced health insurance spending on hospitals of about \$50 billion annually. Based on Lichtenberg's (2007) findings on the distribution of savings across types of health spending, the additional utilization resulting from PBM services save insurance plans another \$31 billion annually in home health care, office visits, outpatient, and emergency room. Although in principle the increased adherence resulting from PBM services could either increase or decrease nonpecuniary adherence costs experienced by patients while it decreases nonpharmacy spending, to be conservative I assume that the net nonpharmacy benefit to plans and their members is half (\$40 billion per year) of the pecuniary nonpharmacy savings.²³

III.E. Specialty PBMs and ancillary services for added value

Because the patient is a critical part of the administration of care, the patients' value of each prescription dispensed can be further enhanced by PBM services to the extent that it can reduce patient time and effort or increase its efficacy. Mail pharmacy is an important instance that is quantified in the previous section. PBM services reduce patient time and effort at retail pharmacies by providing a seamless technology interface that checks patients' coverage and adjudicates pharmacy claims in real-time (while the patient is standing at the pharmacy counter), unlike other parts of the health benefit. With almost four billion annual prescriptions dispensed at retail pharmacies, saving patients just \$6 worth of time and effort per transaction would by

²³ Markups on forgone nonpharmacy medical care are another reason why the aggregate value may be less than the reduced expenditure. In preparing Table 1 I record all the nonpharmacy benefit as an internalized benefit, as it is to the extent that the same plan covers both drug and other healthcare claims. Alternatively, the nonpharmacy benefits could be recorded as external effects.

itself exceed all plans' spending on PBM services.²⁴ PBM drug utilization reviews and checks for unsafe interactions both help reduce premiums while improving patient health.

IV. The Societal Value of PBM services

Trade agreements between plans, patients, and manufacturers are executed for the mutual benefit of the parties to those agreements. However, the resulting actions by the parties to the agreement have important effects on others. One “external effect” is that PBM promotion of generics, agreements with brand manufacturers, and other activities reduce drug expenditure, which is partly an expense for taxpayers through various subsidies for health insurance. A second external effect is that agreements conferring net benefits on manufacturers of new drugs encourage medical innovation activities to create successful new drugs, whose discovery not only benefits the innovator but also future patients. Agreements imposing net costs would have the opposite effect. As explained below, I estimate that the net external benefit of PBM services through these two channels combined is \$53 billion annually. The net societal value is the sum of the net private benefit (that is, to participants in the supply chain, quantified in Section III) and the net external benefit quantified in this section.

IV.A. Drug savings translate into reduced tax distortions

Drug plans, and health insurance generally, are often subsidized by federal, state, and local governments. The subsidies are sometimes direct, as with the Medicaid system, or sometimes indirect as with the exclusion of employer health insurance premiums from personal income and payroll taxation. Governments save money when the plans they subsidize save money that is passed through to reduced premiums. This savings is already counted in Table 3 and 4 on behalf of plans and patients. However, taxpayer savings has an important side effect on the rest of the economy because either tax rates can be cut, or government spending increased. The magnitude of this effect is known as the “tax distortion” or “marginal excess tax burden” (METB) (Dahlby 2008). The METB is widely used in academic policy analysis and is

²⁴ At the 2020 average hourly wage of \$29.36, \$6 worth of time is equivalent to 12 minutes (Federal Reserve Bank of St. Louis 2022). Number of retail dispenses (3.79 billion in 2019) is from Henry J. Kaiser Family Foundation (2020).

recommended by the White House Office of Management and Budget (1992, 2003) for regulatory impact analysis.²⁵ Table 5 uses a METB of 0.5 in order to reflect the various taxes, markups and implicit taxes in the economy where the tax liabilities accrue (Council of Economic Advisers March 2019).²⁶

Table 5. External Costs and Benefits of PBM Services

Rebate transactions and promotion of generics

External benefit (cost is negative)	\$ billion/year		
	Rebates	Generics	Total
Reduced tax distortions because taxpayers save on:			
Nonpharmacy healthcare subsidies			14
Drug plan subsidies	20	13	33
Increased pace of drug development	13	-7	6
Total	33	6	53

Note: Tax distortion estimates assume that the marginal excess burden of taxation is 50%.

Sources: Table 3 demand analysis; Table 4, Mulligan (2021).

The first row of Table 5 derives from the aforementioned \$40 billion annual savings on nonpharmacy health plan expenses. I estimate that 69 percent of those savings ultimately accrue to taxpayers, especially in their role in, at the margin, fully subsidizing premiums for Medicaid and other government health programs other than Medicare.²⁷ Using the METB factor of 0.5, that puts the annual value of reduced tax distortions at \$14 billion.

The remaining rows of Table 5 separately track the effects of management of branded drugs (“rebates”) and PBM promotion of generics. Based on Table 3’s demand model, I estimate that management of branded drugs reduced drug-plan expenditure by \$68 billion, which is less than the rebate itself because of the additional utilization. At a subsidy rate of 58 percent

²⁵ OMB (2019) recommends that more federal regulatory impact analyses use the METB.

²⁶ CEA (March 2019) uses a METB of 0.5. OMB (1992) recommends a METB of 0.25, but this does not include state and local taxes, implicit taxes (which have increased since A-94 was published), or markups in the economy.

²⁷ I assume that the subsidy rates are 74.5 percent for Medicare premiums (Henry J. Kaiser Family Foundation 2021), 43 percent for employer-sponsored insurance premiums, zero for premiums paid into non-ACA individual plans, and zero for out-of-pocket expenses. The (calendar year 2020 from Centers for Medicare and Medicaid Services (2021)) weighted average of these rates is 69 percent when weighted by non-drug expenditure and 58 percent when weighted by drug expenditure. The “drug plan subsidies” row of Table 5 would show somewhat greater estimates to the extent that government also subsidizes out-of-pocket expenses, as discussed further below in connection with Medicare Part D reinsurance.

and METB of 0.5, that puts the annual value of reduced tax distortions at \$20 billion. Promotion of generics reduces expenditure by \$46 billion annually (Table 4), 58 percent of which is government savings, thereby reducing tax distortions by \$13 billion annually.

The Department of Health and Human Services (84 FR 2360) and MEDPAC (2017, Table 14-9) assert that rebate transactions are used by manufacturers, plans and PBMs to increase total government spending on Medicare Part D because rebates purportedly increase the share of patient costs that are out-of-pocket rather than premium. For the commercial market at least, this is incorrect because plans (or PBMs on their behalf) reallocate patient expense between premiums and copays by setting copayment rates, which is one of the reasons why manufacturers have a profit motive to negotiate about plan design. However, Medicare Part D regulates copayment rates, especially for Low Income Subsidy (LIS) participants and the subset of high-cost enrollees who receive government reinsurance subsidies equal to 80 percent of their drug spending at list price. Increasing the list price and rebate one-for-one can increase Medicare spending on reinsurance, but it also likely increases refunds paid to Medicare by the plan under Part D rules for sharing rebates. Social Security's Office of the Chief Actuary (84 FR 2360) as well as the Congressional Budget Office (2019) concluded that the net of these two additional effects of rebates on Medicare Part D spending are dwarfed by the premium-reducing effect of rebate transactions that is the basis for my Table 5.

Regulated copayment rates can also reduce the shift to generics, compared to what occurs in commercial plans, because the regulations can reduce a patient's skin in the game. A Part D plan may cover a branded drug even when a generic is available because, for example, the generic may come in a different dosage or using a different molecule to treat the same condition and the Medicare program finances most of the extra cost of the brand. This is not a problem with PBM services but rather a distortion created by Medicare's copayment regulations, which is one of the reasons why a series of President's Budgets and the 2019 Prescription Drug Pricing Reduction [bill] proposed relaxing some of the regulations. Indeed, that proposal is grounded in the expectation that plans (or PBMs on their behalf) do successfully and significantly reduce drug costs when presented with a financial incentive to do so. Regardless, the historical less-than-full shift to generics is reflected in the calculations in this paper.

IV.B. Reducing drug prices while encouraging drug innovation

Because drug sales revenue is an essential motivation for private-sector drug development and PBMs work to obtain reduced drug prices, drug development and PBM services would appear to be in conflict. However, additional utilization, and not just rebates, is also an outcome of plan-manufacturer negotiations. The relative importance of these two outcomes varies across drugs according to their age and characteristics. Manufacturers of unique new drugs – the drugs that add the most value – benefit from plan-manufacturer negotiations because of the additional utilization that occurs while paying a comparatively low rebate rate.²⁸ In contrast, plans (or PBMs on their behalf) extract greater rebates from the manufacturers of older or “me too” drugs.

This competitive landscape can be understood by distinguishing how a manufacturer’s own activities affect its bottom line versus the profitability of its competitors, and vice versa. Holding constant what its competitors are doing, any manufacturer benefits from its plan negotiations – even those that grant rebates – because it always has the option to sell only at list price. A manufacturer is harmed by its competitors’ plan negotiations in the likely case that the competitors’ sales reduce its own.

The competitor effect is negligible for a manufacturer whose product is sufficiently unique. Some products face significant therapeutic competition even from the first day they are approved for the market. Others have little competition at first, but later face additional competition as therapeutic substitutes are introduced and then again when the patent expires.

Unique new drugs are a small fraction of all drugs, as evidenced by the fact that 90 percent of drugs dispensed are generics. Even among spending on branded drugs, only ten percent is on single-source drugs, which means that the patent has not yet expired (Lakdawalla and Li 2021). Even among those, many faced significant competition from manufacturers of alternative drugs treating the same condition. In this way PBM services reduce aggregate manufacturer revenue even while ultimately increasing the revenue for the small fraction of drugs that are unique and new.

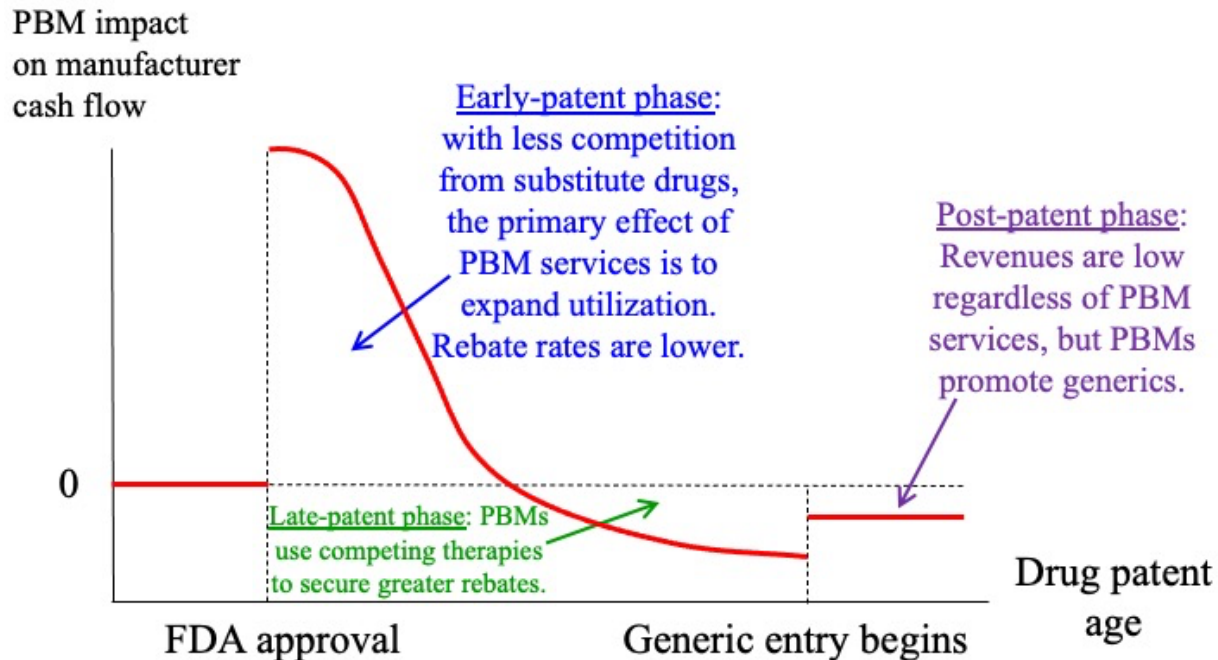
²⁸ The fact that PBMs extract comparatively little rebate from unique new drugs (Sood, et al. 2020) suggests that the rebates reflect competition among manufacturers rather than monopsony power of PBMs. See also CBO (2022), which explains how the “availability of substitute drug therapies gives insurance plans leverage they can use to negotiate larger rebates from manufacturers—for instance, by threatening to favor another manufacturer’s drug by offering it to beneficiaries for a smaller copayment.”

As a simple approximation to this reality, I assume that each drug faces the least competition when its patent is new. During this early-patent phase, manufacturers enjoy enhanced utilization from PBM services and pay comparatively less rebate due to less competition from therapeutic substitutes.²⁹ Over time, new substitute drugs enter the market and older substitutes begin to have generic versions, which give PBMs leverage to insist on greater rebates. This reduces the manufacturer's benefit from PBM services, and over time potentially turns it into a cost (through the competition effect) as illustrated in Figure 2. When the patent expires and generics enter, the manufacturer's cash flow is reduced with or without PBM services. Therefore, on the scale of the revenues at stake before patent expiration, PBM services are therefore not as significant a determinant of profitability. PBM services do tend to reduce the branded manufacturer's cash flow to the extent that generic sources are promoted, which is why Figure 2's cash flow impact is shown as slightly negative during the post-patent phase.

²⁹ Before the early-patent phase is a Food and Drug Administration (FDA) approval and review phase when no sales occur.

Figure 2. Benefit Management Reduces Drug Prices while Rewarding Drug Innovation

Innovation incentives depend on cash flow NPV.
Only a small fraction of drugs are in the early-patent phase.



The red curve is the difference between cash flow with benefit management ("PBM") and what cash flow would be without PBM.

Because the vast majority of drugs utilized are in the post-patent phase or the late-patent phase, a consequence of PBM services is to, on average, redistribute revenue from manufacturers to plans at a point in time. This is the redistribution shown in my Tables 3 and 4. However, the drug innovation decision depends on the present value of each drug's cash flows discounted back to the time of the research and development expenses. For this purpose, the early-patent positive effect of PBM services on manufacturer cash flow looms large and potentially outweighs the negative effects in the two later phases.³⁰

For quantitative comparisons of the three phases, I use Table 3, which refers to all branded drugs, to describe the late-patent phase. To describe the with- and without-PBM scenarios for the early patent phase, I take the same market demand curve from Table 3 (linear case) and the table's implied bargaining-cost function and assume that it coincides with the

³⁰ This is related to the conclusion that post-patent generic competition can significantly reduce average drug prices without much deterring drug innovation (Mulligan 2021b).

manufacturer-level demand curve. Because the market demand curve is the less elastic of the two cited in Table 2, the early-phase manufacturer sets list price higher than the late-phase manufacturer does.

I estimate that PBM services expand quantity 91 percent and manufacturer revenue 40 percent, compared to making all sales at list price, in the early-patent phase although not to the level of utilization in the late-patent phase when list price will be lower and rebates more generous.³¹ If both phases had PBM services, then annualized early-phase revenue would exceed annualized late-phase revenue by more than 200 percent. Generics enter 11.5 years after the brand receives FDA approval, when I assume that branded revenue further declines by 87 percent in both the with- and without-PBM scenarios, based on Mulligan’s (2021b) analysis of generic competition. With these parameters and a six percent annual discount rate, the net present value (NPV) of introducing a new drug is positive as long as the early-patent phase lasts at least 31 months.³² In what follows, I assume a four-year early phase and a 7.5-year late phase, which means that PBM services increase the NPV of branded-manufacturer revenue by 9 percent and thereby encourages drug innovation.

In order to translate a drug innovation incentive (measured as a proportional increase in the NPV of revenue) into a value to society of the resulting new drugs, I assume that (i) R&D expenditure is $r = 15$ percent of revenue, (ii) that the marginal dollar of R&D has expected NPV of a dollar to the manufacturer in terms of leading to a marketable new product, and (iii) the manufacturer captures $s = 26.6$ percent of the (NPV) social surplus of its new drugs.³³ It follows that each dollar of redistribution from manufacturers to consumers has a deadweight cost of $(1/s-1)r = 41$ percent in terms of the social opportunity cost associated with less innovation. This implies an \$13 billion annual additional societal value created by the drug innovation that is

³¹ With PBM and post-patent quantity normalized to one, market-level quantities are 0.757, 0.947, and 1 in the early-, late-, and post-patent phases, respectively. Quantities without PBM services are 0.396, 0.706, and 1, respectively.

³² To put it another way, the revenue NPV is positive if the early-patent phase lasts at least 24 months and the annual discount rate is at least 10 percent. While referring to *revenue* NPV in order to interface with a previous literature on drug-innovation incentives, I note that *profit* life cycles (and the PBM increment to them) are even more front loaded than revenues are. This is another reason that my results may understate the degree to which PBM services encourage innovation.

³³ The manufacturer share of social surplus is from Mulligan (2021b). The unit elasticity of R&D with respect to revenue is in the middle of the range of elasticities estimated by the studies reviewed in Philipson and Durie. They use a somewhat greater elasticity that would result in greater social benefits of PBM than shown in my Table 5.

created or accelerated by PBM negotiations with brand manufacturers, as shown in the third row of Table 5.

As estimated in Table 4, PBMs' promotion of generics especially reduces branded-manufacturer revenue at a point in time that, holding constant early- and late-phase rebates, discourages drug innovation. However, this disincentive occurs late in the drug life cycle and is therefore comparatively small in NPV. As a result, the third row of Table 5, "generics" column, shows only a \$7 billion opportunity cost from reduced drug development. The combined effect of PBM activities toward brands and generics is to encourage drug development to a degree that creates \$6 billion in additional societal value annually.

Altogether, the various social net benefits shown in Table 5 total \$53 billion annually, as entered in the two "external effects" rows of Table 1. That brings the total quantified benefits of PBM to \$148 billion annually. Subtracting the \$22 billion resources used by PBMs (and paid by plans) annually in provided their services, the net value created by PBM services is \$145 billion, which is the sum of \$92 billion in private benefits and the \$53 billion in external benefits. The net value to plans and patients, who are the clients of PBMs, is \$240 billion which exceeds the net private benefits due to the redistribution from manufacturers and pharmacies shown in Tables 3 and 4.

V. Alternative Baselines: Price Controls and In-house PBM Services

Thus far this paper refers to a "no PBM services" baseline. Indeed, in the early days of drug coverage, claims were less numerous, and benefits were largely unmanaged (Navarro 1999). Nevertheless, it is worth considering two potentially likely substitutes for PBMs: government price controls and PBM services self-provided by plans. In doing so, the no-PBM estimates already presented in Tables 1-5 and the corresponding economic analysis prove to be useful ingredients.

V.A. Price Controls

A familiar international alternative to PBM services is government price controls (Danzon 2015, p. 245, Lyles 2017, p. 495). The essential economics of drug-manufacturer price controls is that the government reduces its purchases in order to pressure manufacturers to accept

lower prices or risk being excluded from the jurisdiction. Whereas PBM services expand the economic pie in the process of reducing plans' drug costs, price controls reduce the economic pie as they attempt to redistribute it from manufacturers to plans and patients.

The reduced utilization resulting from price controls may occur through regulations on who is eligible for the treatment or by delaying the initial deliveries as manufacturers prioritize deliveries elsewhere in the world. In 2020 the European Union committed to collective purchasing of COVID-19 vaccines, which resulted in population-vaccination delay of about two months (Pop 2021). Mulligan (2021a) estimates that such a delay cost approximately \$10,000 per household in terms of additional mortality and forgone economic and personal activities.

Although negotiations between plans and manufacturers might be legally permitted under a price regulation system, plans and manufacturers would have little incentive to engage in them if the regulations require negotiated discounts to be extended to any purchaser. For example, a manufacturer offering an additional discount for favorable placement in a plan will have to extend the discount to other plans as well. At that point, the first plan would be at a competitive disadvantage because it is the only one required to provide the favorable placement but not the only one getting the discount. This prediction accords with the observation that PBMs are uncommon in countries where government sets drug prices. Therefore, price controls likely forgo all the private benefits and costs shown in Table 1 other than the two pharmacy benefits (unless retail pharmacy charges were also regulated). They would also forgo the taxpayer savings resulting from PBM services aside from the rebate savings, which price controls are promised to deliver by regulation or statute than rather private-sector competition. Specifically, those forgone net “static” benefits are \$112 billion.³⁴ Possibly price controls would reduce utilization even below the no-PBM level representing the Table 1 baseline, in which case these opportunity costs of price controls would be even greater.

Aside from effects on utilization, price controls are also expected to reduce drug innovation, which is sometimes called a “dynamic” cost of price controls. Following Philipson and Durie's (2021) analysis of the Lower Drug Prices Now bill (HR3), I assume that U.S. price controls would reduce branded manufacturer global revenues by 29 percent, which I take to be a reduction of \$179 billion per year. With each \$100 of redistribution from manufacturers to

³⁴ $112 = 51 + 16 + 40 + (47 - 20) - 22$, where the term in parentheses is the value of reduced tax distortions that PBMs deliver through increased utilization and shifting that utilization to generics (recall the comparison with Europe).

consumers having a deadweight cost of \$41 (recall Table 5), the net cost of price controls in terms of reduced drug innovation at \$74 billion per year plus the \$6 billion worth of drug innovation forgone just from eliminating PBM services. Arguably drug innovation would be reduced even more due to the political temptation to go after the most expensive drugs, which tend to be the unique new ones and the ones with high social value, as contrasted with the existing market where PBMs extract the largest rebates and promote generics later in the drug life cycle where the concessions are comparatively small in the manufacturer's NPV calculus.³⁵ Adding in the other sources of value from PBM services that would be eliminated by price controls (i.e., static costs of price controls), the annual value of PBM services relative to price controls is \$192 billion.³⁶

V.B. In-house PBM Services

From a historical perspective, PBMs have a relatively new business model and even today are uncommon outside the U.S. In the early days of drug coverage, claims were less numerous, and benefits were largely unmanaged (Navarro 1999). As the volume of scripts grew so did the management skills of plans' internal pharmacy departments. Today some plans have their own PBM services although in doing so they seek to realize scale economies and the benefits of division of labor by also servicing other plans with their PBM. My purpose here is to consider a hypothetical in which PBM regulation becomes onerous enough that PBM services, if any, are self-supplied by each plan.³⁷

The aggregate benefits of PBM services documented in Table 1 vary across transactions. With self-supplied PBM services being more expensive, less PBM services would be done. The PBM activities that remain would be the relatively valuable ones because only they would justify the elevated costs of PBM services. To a second-order approximation, the net value of PBM

³⁵ There is also the possibility that manufacturers capture the regulatory process in a way that raises prices on older drugs while discouraging entry of innovative new drugs (Stigler 1971). In this scenario, price controls are fully opposite of PBM services, with the former increasing prices on average while discouraging innovation.

³⁶ About half of the \$192 billion in societal value is from the fact that PBM activities encourage drug innovation whereas price controls discourage them. Relative to a price control regime, PBMs reduce expenditure on the older drugs that are the vast majority of prescriptions but increase expenditure on unique new drugs. Other societal benefits of PBM services come from better drug utilization.

³⁷ Some proposed regulations, such as regulations that limit relationships between plan premiums and member out-of-pocket costs, obstruct the provision of PBM services regardless of whether they are provided internally or by dedicated PBM companies. The cost of such regulations would include the entire value of the forgone PBM services rather than the additional cost of providing them in house.

services is quadratic in the fraction of PBM services worth retaining when plans must self-supply.³⁸ For example, if the cost of self-supply is such that only half of the PBM services are worth retaining, then the net value of in-house PBM services would be one fourth (the square of $\frac{1}{2}$) of what is shown in Table 1. If instead only one third are worth retaining, then the net value of in-house PBM services would be one ninth of Table 1.

As a rough guess as to what might happen, I note that four major health insurance companies – UnitedHealth, Anthem, Aetna and Cigna – already have their own PBM. Their combined share of private health insurance is 48 percent (Waddill 2021, Paavola 2019). Presumably other smaller companies would begin in-house PBM services while at the same time the big four do less for their own plans due to the forgone scale economies. My best guess of the in-house PBM model is therefore that between one fourth and one third of PBM services are forgone, putting the net cost of the in-house approach at \$64-81 billion annually. These net costs are comprised of forgoing Table 1’s itemized net benefits as well as increased resource costs of providing PBM services. Manufacturers and pharmacies would likely be more profitable under the in-house PBM scenario, which means that the costs to plans and ultimately patients exceed the \$64-81 billion annual net.

³⁸ This quadratic result can be derived from a linear marginal benefit curve and a horizontal marginal cost curve that reflects the regulatory costs including the costs of extant regulations such as “any willing provider” laws, reporting regulations, and rebate regulations.

VI. Conclusions

Borrowing a rhetorical device from Karl Marx, manufacturers and pharmacies sometimes refer to dedicated pharmacy benefit management companies (PBMs) as “middlemen” as if the PBMs were supply-chain toll collectors performing no legitimate economic function.³⁹ Insurance-plan sponsors – including state and federal governments in their roles as plan sponsors – do not agree. In pursuit of better value for their members, plans consistently retain PBMs to help design their benefit, negotiate prices, and process claims. In several instances plans have launched their own PBMs to service plan members. Leaving the drug benefit unmanaged would be expensive and wasteful, even if it did partially relieve manufacturers and pharmacies of competitive pressures.

This paper quantifies the value of pharmacy benefit management in a framework that permits analysis of scenarios that involve regulatory or tax constraints on PBM services. The value is estimated relative to three baselines, with the results summarized in Table 6. Compared to having no PBM services, approximating an early era of U.S. prescription drug plans as well as the current situation in many foreign markets, PBM services are worth at least \$145 billion annually. PBM services add at least \$192 billion in societal value annually compared to a price-control regime, which would have neither PBM services nor the pace of drug innovation we have today. Requiring all PBM services to be self-provided by plans would preserve about 60 percent of the value of PBM services but forgo the other 40 percent largely by increasing the cost of executing PBM services.

Table 6. The Value to Society of PBM Services

<i>Relative to Three Baselines</i>	Value in \$
Baseline	billions/year
No PBM services	145
Price controls	192
In-house PBM services only	64 to 81

Notes: The price-control baseline also has almost no PBM services. The value to society includes net benefits to supply-chain participants as well as the net value of government savings and effects on the pace of drug development.

³⁹ Wilson (2021). Marx (1867/1887) employs this device in Chapters 15, 25, 29, and 31 of his *Capital*, Volume I.

While PBMs obtain significant savings for their clients – health plans and ultimately patients, PBM services also expand the economic pie in prescription markets. They actively encourage proper utilization and adherence as well as help to remove patient barriers such as high prices, inaccurate drug information and misaligned incentives to initiate and complete courses of treatment. These are net benefits in terms of better health and patient convenience, only part of which is savings in the form of reduced health expenditure. PBM services also redistribute from manufacturers and pharmacies to consumers as PBM negotiations and plan design fuel competition that lowers retail and manufacturing prices. PBM services ultimately, if not intentionally, encourage drug innovation by increasing utilization early in the patent life where sales are most important in terms of creating a financial return to developing new drugs. By saving governments money and thereby limiting their need to increase distortionary taxes, PBM services even benefit the wider economy. In order to be conservative and to avoid double counting, my estimates do not include specific estimates as to the significant value of PBM services in terms of preventing medication errors, preventing fraud, and providing a seamless technology interface.

VII. Appendix I: Table 3 Analytics

The purpose of this appendix is to provide the analytical framework used to produce the quantitative results shown in Table 3. In this model, the marginal cost of the drug is normalized to one. Consumers have preferences over the quantity q of a manufacturer's drug and the quantity Q of sales by competitors, where q and Q are symmetric substitutes. With no income effects, demand functions that are linear in prices, and efficient quantities that are $q = Q = 1$ (a normalization of quantity units), the preferences must be those described by (up to the quasi-linear term in expenditure on goods other than q and Q):

$$u(q, Q) = \frac{1}{\eta} \frac{(q + Q)(\eta - 1)\varepsilon + \left[(\eta - \varepsilon)qQ - \varepsilon \frac{q^2 + Q^2}{2} \right] \frac{\eta + \varepsilon}{\eta - 2\varepsilon}}{1 + \varepsilon} \quad (1)$$

where the constants η and ε satisfy $\varepsilon < \eta < 0$ and $\varepsilon < -1$. If consumers are allowed to purchase any amount of q and Q at prices p and P , respectively, their demand functions are:⁴⁰

$$q = \frac{(\varepsilon + 1)[\varepsilon p + (\eta - \varepsilon)P] + (1 - \eta)\varepsilon}{\eta + \varepsilon} \equiv D(p, P) \quad (2)$$

and the symmetric demand function for $Q = D(P, p)$.

VII.A. Ex poste competitive equilibrium

A seller charging p , taking competitor's price P as given, maximizes profits $(p-1)q$ at price:⁴¹

$$p = \frac{1}{2} \left(\frac{\varepsilon + \eta}{1 + \varepsilon} - \frac{\eta - \varepsilon}{\varepsilon} P \right) \quad (3)$$

In a symmetric equilibrium with $P = p$, this equilibrium price is $\varepsilon/(1+\varepsilon) > 1$. At this price, q 's own price elasticity of demand is $\varepsilon < 0$, its cross-price elasticity of demand is $\eta - \varepsilon > 0$ (i.e., q and Q are substitutes), and the market-level elasticity of demand is $\eta < 0$. The corresponding quantities are $q = Q = \varepsilon/(\eta + \varepsilon) < 1$.

⁴⁰ Here it is assumed that the prices are below the choke prices, so that nonnegativity constraints on demand do not bind. Although constants could be added to $u(q, Q)$ without changing the demand functions, other monotone transformations of u would alter D by changing marginal rates of substitution with the outside goods.

⁴¹ This is the "ex poste competitive equilibrium" described by Klein and Murphy (2008, p. 447).

To model unique new drugs (Section IV), I derive the demand function for a consumer with preferences (1) constrained to have $Q = 0$, because, by definition, no competitor exists. The point on that demand curve with maximum profits is at a price of $\frac{\eta+(2\eta-1)\varepsilon}{2(\varepsilon+1)\eta} > \frac{\varepsilon}{\varepsilon+1}$.

VII.B. *Ex ante competitive equilibrium*

Rather than trading at p , the q manufacturer and potential consumers could mutually agree to trade units beyond $D(p,P)$ at prices less than p . Some trade of this type, which Murphy, Topel, and Synder (2014) refer to as “quantity commitment discounts” is to be expected given the large gap between p and marginal cost (recall Table 2). On the other hand, trade at multiple prices and committing consumers to be off their demand curve introduces its own distortions, which I refer to as “contract compliance” costs. These additional costs include imperfect allocation of the good among consumers, who differ in terms of willingness to pay, and resources spent by consumers as they attempt to trade or accumulate outside the quantity commitment agreement (Oi 1971, Stole 2007). Klein and Murphy (2008) emphasize that buyers’ clubs such as insurance plans (or PBMs on their behalf) can facilitate the consumer commitments involved with improving on the *ex poste* competition; see also Section III.A. of this report.

A quantity commitment can be represented as a list price l , a rebate rate r , and a marginal price m , which induce consumers to purchase $D(m,M)$ from, and pay $(1-r)l D(m,M)$ to, the q manufacturer.⁴² I represent the compliance costs with a function that is quadratic in the average gap between the list prices $\{l,L\}$ and corresponding marginal values $\{m,M\}$. When a seller does not obtain quantity commitments, its list and marginal price are equal and therefore the seller’s trade makes no contribution to compliance costs. The symmetric equilibrium full marginal cost of supplying q through a quantity commitment is therefore the left-hand side of (4):

$$1 + \frac{c}{-dD(m,m)/dm} \frac{l - m + L - M}{2} = m = M > 1 \quad (4)$$

⁴² M and L denotes the marginal and list prices, respectively, offered by the competitor (either as part of another quantity commitment or at a single list price). The marginal prices m and M can be simply interpreted as patient copayment rates, although plans and other PBMs have additional tools to encourage utilization such as mail pharmacies and other delivery and administration conveniences.

where $c > 0$ is a constant and the equality reflects the bargaining outcome that marginal value m equals the full marginal cost of q .⁴³

Given parameter values $\{c, \varepsilon, \eta, \beta\}$ satisfying $c > 0 \wedge \varepsilon < \eta < 0 \wedge \varepsilon < -1 \wedge 0 \leq \beta < 1$, a quantity commitment equilibrium under oligopoly is a list $\{q, Q, l, L, m, M, r, R, q_0, Q_0\}$ satisfying (i) – (vii):

- (i) Symmetry: $q = Q, l = L, r = R$,
- (ii) Consumer rationality: $q = D(m, M)$ and $Q = D(M, m)$,
- (iii) Marginal value equals full marginal cost (4),
- (iv) Taking competitor's prices L, M , and R as given, the list price l and fallback sales q_0 maximize the q seller's profits when it does not obtain a quantity commitment subject to the constraint $q_0 = D(l, M)$:

$$l = \operatorname{argmax}_l (l - 1)D(l, M) \quad (5)$$

- (v) Taking prices l, m , and r as given, the competitor's list price L and fallback sales Q_0 maximize the Q seller's profits when it does not obtain a quantity commitment subject to the constraint $Q_0 = D(L, m)$:

$$L = \operatorname{argmax}_L (L - 1)D(L, m) \quad (6)$$

- (vi) The surplus accruing to consumer and q seller from the q quantity commitment is split between the two parties in shares β and $1 - \beta$, respectively:

$$\frac{\beta}{1 - \beta} = \frac{u(q, Q) - (1 - r)lq - (1 - R)LQ - c \left(\frac{l - m + L - M}{2} \right)^2 - s_0}{[(1 - r)l - 1]q - (l - 1)D(l, M)} \quad (7)$$

$$s_0 \equiv u(q_0, D(M, l)) - lq_0 - (1 - R)LQ - [D(M, l) - Q]M - c \left(\frac{L - M}{2} \right)^2$$

- (vii) The surplus accruing to consumer and Q seller from the Q quantity commitment is split between the two parties in shares β and $1 - \beta$, respectively:

⁴³ The level of compliance costs is $c \left(\frac{l - m + L - M}{2} \right)^2$.

$$\frac{\beta}{1-\beta} = \frac{u(q, Q) - (1-r)lq - (1-R)LQ - c\left(\frac{l-m+L-M}{2}\right)^2 - S_0}{[(1-R)L-1]Q - (L-1)D(L, m)} \quad (8)$$

$$S_0 \equiv u(D(m, L), Q_0) - (1-r)lq - [D(m, L) - q]m - LQ_0 - c\left(\frac{L-M}{2}\right)^2$$

Equilibrium conditions (i)-(iii) by themselves indicate the equilibrium quantities as a function of list price L .⁴⁴ Either (iv) or (v) provides a formula for the equilibrium list price that is between one and the list price $\varepsilon/(1+\varepsilon)$ resulting from *ex poste* competition. Using that value to augment (i)-(iii), the equilibrium quantities and list prices are:

$$q = Q = \varepsilon \frac{(\varepsilon + \eta)c - 2(\varepsilon + 1)\eta}{(\varepsilon + \eta)^2 c - 2(\varepsilon + 1)\eta\varepsilon} \in \left(\frac{\varepsilon}{\eta + \varepsilon}, 1\right) \quad (9)$$

$$l = L = \frac{1}{\varepsilon + 1} \frac{(\varepsilon + \eta)^2 \varepsilon c - (\varepsilon + 1)(\varepsilon + 2\varepsilon^2 - \eta)\eta}{(\varepsilon + \eta)^2 c - 2(\varepsilon + 1)\eta\varepsilon} \in \left(1, \frac{\varepsilon}{1 + \varepsilon}\right) \quad (10)$$

The equilibrium quantities exceed the *ex poste* equilibrium quantities although are less than the quantities $q = Q = 1$ that would be efficient without compliance costs.

Conditions (vi) and (vii) yield the equilibrium rebate rates r and R , respectively, from the above expressions for equilibrium quantities and prices. Note in (7) that a q consumer's alternative to the quantity commitment is to purchase q at list price l and purchase additional units from the competitor, at marginal cost M . The analogous assumption is made in (8) for the Q consumer. The share parameter β increases the equilibrium rebate rates r and R . The sharing calculus also reflects the fact that quantity commitments for both sellers involve greater compliance costs than commitments for just one.

Because the rebate rate R decreases in the corresponding list price L , it might appear that a seller could extract more profit from the quantity commitment with a greater list price even though it would mean somewhat less utilization. However, the plans and PBMs could refuse to enforce the quantity commitment in which case any list price different from the result of (v)

⁴⁴ The monopoly case discussed below is helpful for understanding conditions (ii) and (iii) fit together because the monopoly case permits a supply-demand illustration.

would not maximize profit.⁴⁵ Similarly, the plans and PBMs could attempt to extract greater rebates by asserting they will not enforce the quantity commitment and purchase even less than $D(L, m)$, but once purchases are made at list price following through on the assertion would not be consistent with plan-member interests.⁴⁶

Two of the four model parameters $\{c, \varepsilon, \eta, \beta\}$, as well as one of the *ex ante* equilibrium outcomes (r), are shown in Table 2. Regardless of the (unknown) value of c , the values $\{r, \varepsilon, \eta\}$ partially identify β . In particular, β is bounded below because c must be nonnegative. Taking the midpoint of the partially identified set as my point estimate of β , I obtain a point estimate of c from (8) that is used for both the oligopoly and monopoly analysis.

Given parameter values $\{c, \varepsilon, \eta, \beta\}$ satisfying $c > 0 \wedge \varepsilon < \eta < 0 \wedge \varepsilon < -1 \wedge 0 \leq \beta < 1$, a quantity commitment equilibrium under monopoly is a list $\{q, l, m, r, q_0\}$ satisfying (i) – (iv):

- (i) Consumer rationality: $m = \frac{\partial u(q, 0)}{\partial q}$.
- (ii) Marginal value m equals full marginal cost $1 - \frac{\partial^2 u(q, 0)}{\partial q^2} c \frac{l-m}{2}$,
- (iii) The list price l and fallback sales q_0 maximize the monopolist's profits when it does not obtain a quantity commitment subject to the constraint $l = \frac{\partial u(q_0, 0)}{\partial q_0}$:

$$q_0 = \operatorname{argmax}_q \left(\frac{\partial u(q, 0)}{\partial q} - 1 \right) q \quad (11)$$

- (iv) The surplus accruing to consumer and q seller from the q quantity commitment is split between the two parties in shares β and $1-\beta$, respectively:

$$\frac{\beta}{1-\beta} = \frac{u(q, Q) - (1-r)lq - c \left(\frac{l-m}{2} \right)^2 - s_0}{[(1-r)l - 1]q - (l-1)q_0} \quad (12)$$

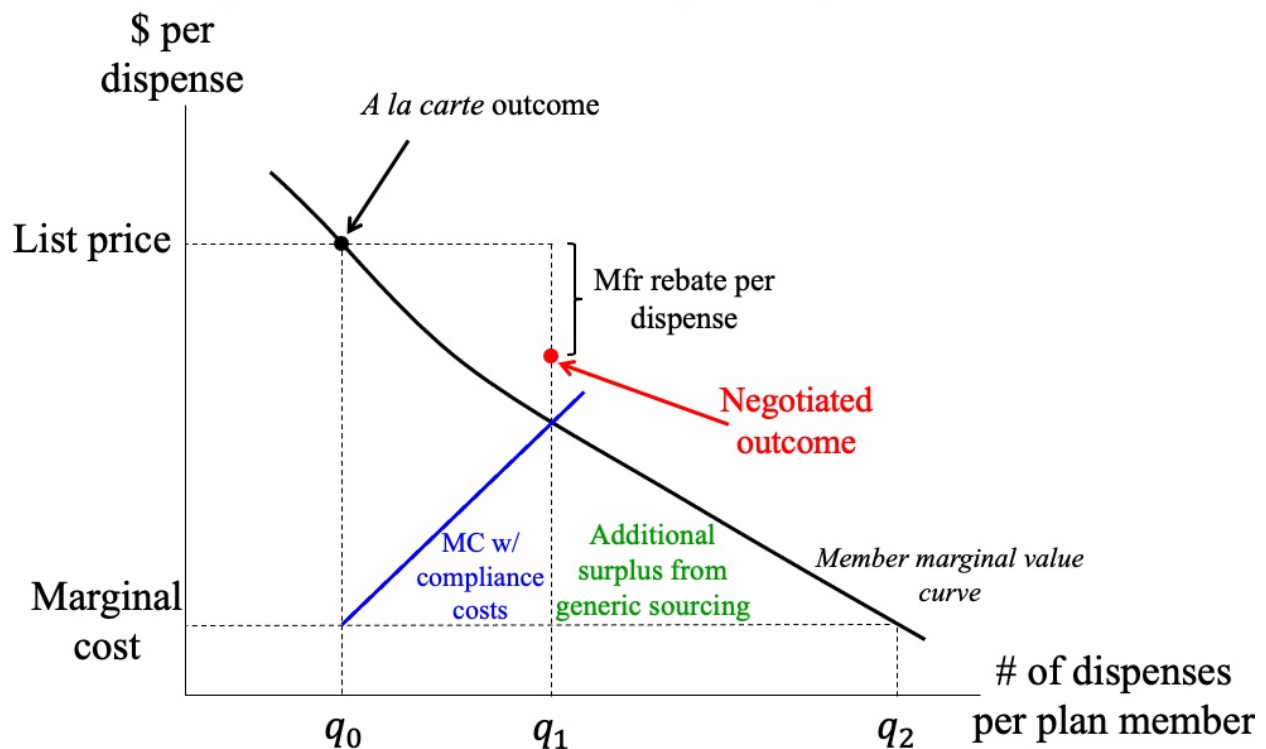
$$s_0 \equiv u(q_0, Q_0) - l q_0$$

⁴⁵ The seller's optimal list price may be less than the monopoly price to the extent that consumers in the bargain can (at a cost) "resell" to consumers paying list price. This "resale" can be within person – for example a plan member stockpiles pills while on the plan and then takes a year off the plan using the stockpile and paying list price – or between persons, as has occurred with prescription opioids, stimulants, and other drugs (Rigg, March and Inciardi 2010, Schnell 2018).

⁴⁶ By using the demand function $D()$, conditions (iv) and (v) already reflect a significant shift of sales from q to Q , or vice versa, if one of the sellers is not obtain a quantity commitment while the other does.

Monopoly conditions (i) and (ii) can be illustrated by augmenting Figure 1, as in Figure 3 below. Any quantity beyond the *a la carte* quantity q_0 involves convex compliance costs. This addition to total marginal costs is therefore zero at q_0 and then, by convexity, increases from there. Figure 3 shows the total marginal costs as a linear blue curve, reflecting the quadratic assumption used in my numerical analysis. Regardless of the quadratic assumption, the equilibrium quantity commitment q_1 is where total marginal cost intersects the marginal value curve. The gains from the quantity commitment are the area between the demand curve and the blue marginal cost curve. The vertical position of the negotiated outcome reflects the sharing of those gains between seller and consumers.

Figure 3. Compliance costs determine the equilibrium extent of quantity commitments



The blue curve is the sum of the marginal cost of compliance with the other (and constant) marginal costs of manufacturing, delivery, etc.

The equilibrium quantity commitment q_1 exceeds q_0 because, in the neighborhood of q_0 , a mutually advantageous movement off the demand curve is possible with little compliance cost. q_1 is less than the “efficient” quantity q_2 because small reductions from q_2 involve forgoing

relatively low value uses while saving significantly on compliance costs. PBM regulations are predicted to reduce the equilibrium quantity commitment q_1 to the extent that they rotate the marginal cost curve counterclockwise in Figure 3. This is represented algebraically by increasing the cost parameter c . Productivity growth in the PBM industry has the opposite effect, which can help explain why PBMs have introduced new methods of managing utilization while rebate rates have increased.

Figure 3 also helps illustrate how I infer the quantity effect ($q_1 - q_0$) of PBM services in the oligopoly case. Because each value of $c > 0$ implies a unique value for q_1 between q_0 and q_2 , each also implies a unique rebate rate (given the sharing parameter β). Therefore, at most one nonnegative value of c is consistent with the average rebate rate I observe (30 percent). The same numerical value of c I infer in the oligopoly case is then used to simulate the equilibrium quantity commitment that consumers have with monopoly sellers.

In the oligopoly case, I estimate that a 30 percent rebate rate is consistent with values of c that are small enough to result in quantity commitments close to q_2 . This is a conclusion consistent with the findings of Lakdawalla and Sood (2013) and others that patent expiration does surprisingly little to increase the size of the market especially when the consumers in that market had drug coverage.

VII.C. Constant-elasticity case

Table 3 also shows a version of the calculations using “constant elasticity” demand. That column is derived by replacing the quadratic function (1) with (13):

$$u(q, Q) = \frac{\eta}{\eta + 1} CES(q, Q)^{(\eta+1)/\eta} \quad (13)$$

where CES is a symmetric homogenous function with constant elasticity of substitution $\eta - 2\varepsilon > 0$ and a constant normalized so that the efficient quantities are $q = Q = 1$. The price elasticity of market demand is therefore the constant $\eta < 0$. Because the symmetric ex post equilibrium price is $\varepsilon/(1+\varepsilon)$, as it is with linear demand, the constant $\varepsilon < \eta$ has the same interpretation as in the linear case.

To facilitate comparison between the two columns of Table 3, I fix the second column’s ex ante list price to be the same numerical value as the first column’s. Given parameter values

$\{c, \varepsilon, \eta, \beta, l, L\}$ satisfying $c > 0 \wedge \varepsilon < \eta < 0 \wedge \varepsilon < -1 \wedge 0 \leq \beta < 1 \wedge l = L > 1$, a quantity commitment equilibrium under oligopoly (and preferences (13)) is a list $\{q, Q, m, M, r, R, q_0, Q_0\}$ satisfying (i), (ii), (iii), (vi), and (vii). As in the linear case, the parameter β is calibrated at the midpoint of the partially identified set, although that set is somewhat different in the constant-elastic case. The value for c is that value that rationalizes the observed 30 percent rebate rate.

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