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Efficiency, Consumer Welfare, and Market Equilibrium in Private Insurance Coverage of Patented Drugs

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Abstract

What is the message? Pharmaceutical prices are set through interactions among drug companies, the sellers, and health insurers. This study offers a series of models demonstrating the impact of monopoly prices on insurance coverage and the consumer.

What is the evidence? An analysis of patented drugs with no close substitutes sold by monopoly drug firms to competitive private insurance plans and the effects of insurance-induced price effects on subsequent changes in co-insurance rates.

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Background and Insured Patient Demand

Private sector insurers are under intense pressure to restrain premium growth in both individual and group markets, especially with regard to pharmaceutical spending. Such growth is largely driven by the diffusion of costly new products, especially by novel brand-name, patent-protected prescription drugs, and by increases in the prices of products or services where there is little competition. Historically, U.S. insurers, public and private, have taken a passive role with regard to the prices or quantities of effective branded drugs *with no close clinical substitutes.* (They might use formularies tiered with copays and reference prices for products for which there were alternative clinical choices (Cremer and Lozachmeur), but that is not the case to be considered here.) Once approved by the FDA, insurers would generally pay for whatever drugs physicians and patients agreed to order at whatever price the drug firm charged. Historically, drug insurance policies often included uniform coinsurance or other forms of cost sharing that applied to all prescription drugs, so consumers were partially exposed to high prices and deterred from higher quantities of covered drugs. This exposure is heightened in modern health insurance, where most policies include drug coinsurance, and few drugs are excluded from coverage.

In this paper, we present a set of models of simultaneous determination and market equilibrium for drug firm price and insurance coverage for “exclusive” branded drugs, those with no close clinical substitutes (new molecular entities or biological products). Such breakthrough drugs constitute a substantial share of the growth in drug spending. Insurers also find their prices difficult to modify even when the insurer has a large market share (Lakdawalla and Yin, 2015). We will explore simple monopoly pricing by the drug firm that insurers are assumed to take as given, but with insurer choice of cost sharing (given the price set by the monopolist) as a way of increasing the welfare of risk-averse consumers. The drug firm is assumed to set the simple monopoly price given demand and a constant (zero) marginal cost of production and distribution.[1] After developing this benchmark model, we will comment on the impact of moving to alternative pricing models for drugs when insurers take a less passive approach with regard to drug price and quantity.

To focus attention on payment mechanisms, we present a benchmark model in which we assume that drug insurance markets are approximately competitive, with no single insurer having a large enough market share among insurance buyers in that location to motivate face-to-face bargaining with any drug firm. Some insurers are national firms (that own pharmacy benefit managers) but they typically tailor their plans to the demands of local employmentbased groups. This assumption allows us to avoid the often-intractable problem of modeling bargaining equilibria in a drug monopoly-insurance monopsony setting.

Our approach will differ from most other commentary on drug pricing and its relationship to insurance (Berndt, McGuire, and Newhouse, 2011; Danzon and Pauly, 2002) by going beyond discussion of what insurance buyers might do when a new drug is introduced at some (high) price. We ask how the seller's price responds to the insurance they choose. We then take the next step and ask how the coverage chosen may change in response to the new price and trace out the independent adjustment process to an equilibrium in seller price and insurance coverage. To our knowledge, modelling the steps of subsequent insurance firm and buyer responses to the insurance-induced increase in branded drug prices along a linear demand curve is a novel contribution, as is the specification of an equilibrium in which the market price and the market level of insurance are mutually consistent.

More specifically, we will deal with the challenging case in which drug firms set prices of branded products based in part on insurance coverage design, while insurers seek to offer cost-sharing designs that patient-consumers will prefer, given the consumers' financial risk associate with a given drug firm price and illness-affected quantity demanded at that price. We focus on a major paradox in the simple monopoly model which has not been recognized: when coverage and price are endogenous, market equilibrium outcomes may leave representative risk-averse consumers worse off or no better off with than without insurance. Alternatively, market equilibrium may not exist.

Modelling

Initial Assumptions

Our focus is on a hypothetical market of competitive profit-maximizing private insurers who can offer varying cost-sharing levels for different drugs and who can refuse to cover a product at all (100% cost sharing), Following a long line of literature, we simplify insurance by treating all cost sharing as a coinsurance percent or proportion (Zeckhauser, 1970; Feldstein, 1973; Feldman and Dowd, 1991).[2] The insurance product is demanded to treat an uncertain illness of potentially varying severity, and risk-averse consumers may demand insurance to cover the financial cost of the drug when they use it. We assume a linear demand curve both because it is a simple way of illustrating consumers' surplus diagrammatically and because the property of high elasticity and high prices and low elasticity at low prices seems most realistic when quantity demanded is bounded by zero and use by all persons with an illness. Insurance demanders, who might be individuals or homogenous groups of individuals, can then choose which combination of coverage and associated premium they most prefer, prior to knowing whether they will get the illness and how severe it will be.

The drug to be covered is sold by a profit-maximizing firm, which has market power because it has a patent on an exclusive drug. In order to characterize a demand curve facing these firms, it must be the case that different potential buyers attach different values to a given product once illness has occurred because it yields different amounts of increased expected health [quality-adjusted life years (QALYs] depending on illness severity. If all persons with the illness a drug treats expect to gain the same number of QALYs from treatment, and have the same monetary value per QALY added, the seller would face a horizontal demand curve and either sell none of the product or sell it to all those with the illness, depending on where it set the price (Pauly, Comanor, Frech, and Martinez, 2021). In what follows, we assume instead that severity (and marginal benefit) varies after illness strikes but that monetary values of QALYs are the same across buyers of drugs and insurance.

We also assume for simplicity that each individual insured person consumes either zero or one drug treatment (Garber, Jones, and Romer, 2006). This allows us to focus on the extensive margin in describing the demand curve for the product. We use a standard two-state expected utility maximization model with moral hazard. For ease of exposition, we ignore income effects on demand and, in most cases, set marginal cost to zero.

The model

Following Feldman and Dowd (1991), we define the "risk premium" π as the value subtracted from income in the no-illness state that equates an individual consumer's expected utility with insurance and some coinsurance rate of c to the expected utility without insurance, or:

$$(1)\ E[V(X - \pi - (1 - c)\, E(PM) - cPM + W(M)] = E[V(X - Pm) + W(m)]$$

Where the utility function is assumed to be separable into two parts, V and W, X= income, c =

coinsurance rate, P =gross price of treatment, M= quantity with this insurance, and m = quantity without insurance. Equation (1) also assumes that the insurance is actuarially fair so that the premium K=E[(1-c)PM].

Then it can be shown (Cf, Feldman and Dowd, 1991) by a second order Taylor series expansion of (1) that π is given by:

$$(2)\ \pi = [[E(P(m-M)] + [E(W(m)] - EW(M)]/V'] + (R\sigma^2)/2.$$

Here the first term in brackets represents the difference in expected spending, the second term represents the difference in value of care received (difference in utility divided by the marginal utility of income), and the last term represents the value of risk reduction from insurance, where R equals the Arrow Pratt coefficient of risk aversion and σ^2 is the variance of out of pocket spending.

The insurance buyer maximizes expected utility by choosing the level of c which maximizes π, the net gain from insurance. Risk arises in this setting because illness is uncertain, its severity conditional on its occurrence is uncertain, and therefore the out-of-pocket spending by the insured is uncertain. Moral hazard arises when the insurance payment is made conditional on the level of care chosen post-purchase and when the severity of illness (or other determinant of care demand) is then only known by the insured but not by the insurer. One of our primary interests in this paper is in the change in medical care use that is incentivized by insurance and resulting consumer welfare cost, so our discussion will be primarily about the first two terms of expression.

To explore the impacts of variation in coinsurance and resulting changes in monopoly price on the risk premium for the representative consumer, we follow Feldman and Dowd in relying on an analysis of the geometric welfare triangle that shows how consumers' surplus changes when market-level coverage and price change. We then compare that change with changes in the value of risk reduction from insurance. We differ in that we assume that the drug firm charges the same price to the insured and the uninsured.

Equilibrium and consumers' surplus without insurance

If there were no insurance (or if insurance could take the form of fixed dollar indemnities conditional on the patient's state of health and the type of illness), the resulting demand curve for the product, which is also the schedule of marginal health benefits, would (ignoring income effects) be the one which would prevail in a simple monopoly market. The drug firm would then set its profit-maximizing price, and patients would choose whether or not to demand the drug at that price. Note that, at the profit-maximizing price, the demand curve will be elastic: if the price is raised above this price enough, consumers will not buy the drug to such an extent that drug firm revenue will fall. (The drug monopolist can set any price it wants but it cannot sell any quantity it wants.) As usual, at the monopoly price there is welfare loss because of this demand response. Consumers' surplus would be lower than if the price were competitive.

This scenario of simple monopoly without insurance predicts a price in excess of marginal cost, but one at which those consumers who do choose to buy the product obtain positive consumer surplus, on average, compared to a situation in which the drug was not available. Many pay less than the value of the benefit they expect to get from the drug. In what follows, we assume that the marginal cost of the drug is zero so that profit and revenue maximization coincide. Consumers' surplus would be maximized if 100% of patients with the illness obtained the drug, but that will not happen in a simple monopoly equilibrium.

Adding insurance with independent adjustment by the drug seller and the buyers of insurance

Because insurer information on the state of a person's health is imperfect, health insurance cannot take the form of predetermined indemnity payments conditional on the health state. Instead, as noted above, we model insurance coverage as using proportional coinsurance to limit moral hazard, with the choice of treatment quantity, given insurance coverage, to be chosen by a patient-doctor agreement influenced by the level of the out-of-pocket payment. (If the patient knew the health state prior to purchasing insurance but the insurer did not, the situation would be one of adverse selection.) The patient and physician are assumed to observe the health state (illness severity) with full accuracy once an illness has occurred. Given the assumption that each person demands one or zero units of drug treatment, the firm and market demand curve for the product without insurance will track the distribution of health benefits from the drug in a given population. If we assume that these benefits are determined by illness severity—sicker people get more benefit from the drug—the market demand curve is defined by the distribution of illness severities. There will be some price so high that no consumers, not even the sickest, will choose to buy the drug, and at a near zero price all members of the population with the illness will buy the drug but no one who is not sick will choose it. The demand curve strikes both price and quantity axes.

We model the choice by risk-averse consumers facing a tradeoff between lower coinsurance (and therefore lower variance of out-of-pocket spending) against greater moral-hazard-caused reduction in consumer surplus. To determine the market equilibrium for insurance coverage and price of this drug, we assume there are numerous insurance purchasers and competing insurers who take the drug seller's current market price as given, and have no foresight about future drug firm price changes. This is the standard Nash assumption.

Begin by assuming that the drug firm faces a known linear demand curve for drugs and that the no-insurance simple monopoly price prevails. Insurers offer coverage with the coinsurance rate that is optimal at that price for consumers, given the consumers' expected marginal benefit curve from the product and given their degree of risk aversion. That would be the level of coinsurance that would maximize the risk premium, given the initial price (the no-insurance price). Thus, the coinsurance rate is determined by consumer preferences. The monopoly seller now faces a different demand curve with P replaced by P/c. This is the equilibrium described by Garber, Jones and Romer (2006).

Figure 1 illustrates the standard argument about the effect of coinsurance on market equilibrium quantity and price. P* is the no-insurance monopoly price. At this price, 50% of patients with the illness buy the drug. The triangle A represents the welfare loss from monopoly pricing. Now suppose that risk-averse consumers choose insurance with the coinsurance c* that maximizes expected utility in equation (2). The presence of insurance will then cause the demand curve faced by the monopolist to rotate upward as indicated. A profit-maximizing seller will react to the demand curve affected by coinsurance by increasing the price to a new higher profit-maximizing level. In figure 1, this change is shown by the pivoting of the demand curve around the x-axis intercept (Pauly, 2012) leading to a new monopoly price, P'. At this new monopoly price P' and the original coinsurance rate c*, the net price settles to the same level as the gross price before insurance. The quantity with insurance is then the same quantity (50% of patients using the drug) as without insurance.

However, this is not the end of the story. What happens next to the coinsurance rate chosen by the representative risk-averse consumer after the increase in price is ambiguous in theory (Phelps, 1973). The desired level of the coinsurance rate may either rise or fall with increases in the market price. Roughly speaking, the direction of this change depends on the representative person's marginal value of risk protection relative to the cost of moral hazard; coinsurance will increase if the former is smaller relative to the latter—and vice versa.

Let us first consider the case where the coinsurance rate increases if P increases. Demanders of insurance may choose this level of coverage because there is a larger marginal welfare loss at a higher price, and that larger welfare loss may more than offset a higher level of financial risk. If coinsurance rises in the market, the drug firm would reduce its price. However, after this increase the user price will again end up at the original gross price. Then coinsurance rises a little again, and the process continues by smaller and smaller steps until it converges to a Nash equilibrium of drug prices and coinsurance. In that independent adjustment equilibrium (if it exists) the level of coinsurance will be optimal for consumers given the drug price, and the drug price will be profit-maximizing for the drug firm given the coinsurance affected demand curve. Formally, the representative consumer chooses the utility maximizing level of coinsurance, given P, described in equation 2 while the drug firm chooses the level of price, given c, which satisfies the usual MR =MC condition with gross price defined as P/c. More importantly, the net price to consumers in the final equilibrium (as in all other stages) is at the same level as the gross user price before insurance was available, and the equilibrium quantity of the drug purchased by 50% of those at risk.

Figure 2 illustrates. It shows the independent-adjustment (Cournot-Nash) process. Following the textbook model (Emerson, 2018), there are two best response reaction curves: one for the drug firm (profit maximizing price given coinsurance) and the other for the representative insurance buyer (expected utility maximizing coinsurance rate given price). The path of prices and coverage given some initial starting point value for c is shown, and the process converges to equilibrium at the intersection point E in this example.

The paradox

We now note a major issue: in this equilibrium (if it exists), the user price equals the initial no-insurance price, and so the quantity demanded is the no-insurance quantity (50% of the population covered). This leads to:

Proposition 1: *Compared to the no-insurance equilibrium, in the insured Nash equilibrium (if it exists), consumers end up with the same expected quantity of care, (at which 50% of patients with the illness use the drug), and the same expected distribution of out-of-pocket payments.*

This positive proposition may appear fairly obvious, though to our knowledge it has not been noted in the literature. What is less obvious and more paradoxical is the welfare implication:

Welfare Implication 1: *In equilibrium consumers are worse off with some insurance than with no insurance. They experience the same out-of-pocket cost, financial risk, and the same quantity as with no insurance, but pay more in premiums.*

Why does insurance fail to provide additional risk protection compared to the risk averse consumer's situation without insurance? The reason is because insurance continues to change the demand curve in ways that raise the monopoly price unless and until the consumer cuts back far enough on insurance coverage. Increasing coinsurance has to catch up with rising prices. In this equilibrium with insurance, the seller now collects in out-of-pocket payments and insurance benefits a total amount which is (potentially much) more than the no-insurance revenue. This inferior equilibrium is still stable because, at the higher product price, consumers will want the insurance they have. However, if the government would forbid the sale of insurance, all consumers would be better off.

Nature and existence of equilibrium

Now suppose that the initial level of ideal coinsurance (given P) was less than 0.5. This implies that after coverage is purchased the profit-maximizing price will be greater than 2P. At that price, the quantity will be 50%. However, at that price and quantity, the consumer will be worse off from purchasing the insured drug. There will not be an equilibrium. In the next round the drug seller will reduce the price to P, the consumer will again choose c less than 0.5, and the process will repeat.

Hence:

Proposition 2*: Equilibrium does not exist if the consumer chooses coinsurance at or below 0.5* *or if the consumer reduces desired coinsurance as price increases.*

If the consumer responded to the higher monopoly price by choosing a lower coinsurance rate, that choice will lead to even higher prices and premiums which will lead to zero insurance. At zero insurance price will fall back to the simple monopoly price, and then buyers will demand insurance with coinsurance below 0.5. Hence the price will move from the simple monopoly price to a price that exceeds the reservation price, and back again—independent-adjustment equilibrium without foresight will not exist.

Adding foresight

It is plausible that the drug monopolist will anticipate future changes in market levels of coinsurance when it changes its price (even if an individual competitive insurer might not anticipate further changes in the drug firm’s price in response only to its own coverage change). That is, the drug seller may know what levels of coverage for its drug (including no coverage) insurance buyers will choose at a given launch price or subsequent price. In the case where coinsurance is increasing in P, a drug seller strategy alternative to the independent adjustment process just described may simply be to set the price at what would be the equilibrium of that independent adjustment process. At that price insurance demanders will choose the coinsurance level that is optimal, and the quantity level of 50%. The outcome will be the same as that previously described but will converge immediately.

The more challenging case is when desired coinsurance falls as price increases. The outcome of no insurance and no drug use is clearly inferior to some other option with a particular price P* and some other level of coinsurance. But if that combination is put in place, buyers of competitive insurance will want more generous coverage and insurance firms will see positive prospective profits from offering it. Prices and coverage will continue to rise to such an extent that no insurance (and no drug purchase at a very high price) is preferable to keeping insurance. When consumers drop all coverage price will fall but that is also not an equilibrium, so the cycle begins again.

As before, foresight may come to the rescue here. The drug firm may choose a price at which buyer insurance coverage and quantity demanded at that price still yields consumers surplus.

From passive to active

Might an individual competitive insurer in at the equilibrium coinsurance rate gain by proposing to the drug seller an alternative arrangement with a new insurance product that carries a lower coinsurance rate in return for the drug seller's promise to charge a lower price? It is commonly believed that an insurer needs to enroll a large share of the users of a branded drug to negotiate with the drug firm — "to be effect as negotiators in pharmaceutical markets, PBMs need size" (Werble, 2017). Is this necessarily true? Might this kind of price negotiation prevail even if each insurer has only a small market share and hence no bargaining power?

The answer turns out to be affirmative. We begin in a Nash equilibrium with a given coinsurance rate c_0 and a given gross price P_0 with quantity Q_0=0.5, at which marginal benefit and user price is c_0P_0. This yields drug firm profits of P_0(0.5). Now consider an offer from the insurer to pay a lower gross price P_1 but demand a higher quantity Q_1 such that drug firm profits are marginally greater than in the Nash equilibrium. That is, the increase in quantity from 0.5 to the larger quantity patients will demand with a lower gross price and lower coinsurance (DQ) exceeds by a small amount e the fall in profits on the original quantity from the reduction in gross price DP.

(3) $DQ(P_1) – DP(0.5) = e$.

The insurer agrees to adjust coinsurance so that demand at gross price P_1 does indeed equal Q_1 at that price. Call this new user price c_1P_1 (This level of coinsurance would generally be lower than the level on the reaction curve at P_1 so it is not a Nash combination.) Hence the user price falls from c_0P_0 to c_1P_1.

At this new point the seller has somewhat higher profits. What is the change in total surplus DCS? It is the change in payments to the insurer, or e above, plus the increase in expected consumers surplus which is:

(4) $DCS = 0.5[c_0P_0(0.5)]-[(0.5-DQ)\ c_1P_1]$

The first term in square brackets is the increase in expected consumers surplus if the user price were reduced from the original level c_0P_0 to zero and quantity increased from 0.5 to 1, and the second term is the shortfall from that amount because user price remains positive at c_1P_1.

That is, the representative insureds consume a larger quantity of care whose value is positive even after paying off the monopolist; they expect more consumers surplus. Hence both sellers of the drug and buyers of insurance are better off at this point than they were in Nash equilibrium. Of course the best deal for insured consumers would be one in which user price was zero (equal to MC) and Q=1 (100% of those who got sick and could benefit from the drug).

We can think of the drug firm's response to the insurer's offer as movement along an all- or-nothing supply curve (Friedman, 1976; Herndon, 2002) along which the required quantity is so large that, at the proposed (lower) per unit price, the seller is just indifferent between accepting the offer and staying at the previous equilibrium (or the chaos of the non-equilibrium case). Effectively, this alternative is identical to proposing a lump sum amount (unit price times maximum quantity) that extracts almost all supplier surplus from the seller. This is also a step in the direction of the two part model of Lakdawalla and Sood (2013).

If one thinks of the drug company as suggesting this type of deal as an improvement from the Nash equilibrium (or non-equilibrium), the drug company would get more surplus and the insurer and its members would be indifferent or near indifferent. It is also possible that insurer and the drug company share the surplus gained by this sort of deal.

Empirical evidence

There is evidence consistent with some of the steps in the adjustment process to independent adjustment equilibrium. There is time series evidence that more generous market-level insurance coverage is associated with higher prices for branded drugs [3]. There are also some examples of drugs with a high original launch price at which insurers refused to offer or greatly limited the number of patients eligible for coverage (coinsurance of unity), followed by substantial price cuts (which happened with the recently introduced high priced drugs Sovaldi and Aduhelm). Finally, the pattern of price increasing from the launch price supported by generous insurance coverage is common.

However, there has been to our knowledge no documentation of the cyclical pricing-insurance coverage interaction suggested by the model. Perhaps foresight, r experience or inertia produces convergence to the independent adjustment equilibrium without the intermediate steps. It would be interesting to see whether there are some novel drugs for which insurers take the price as given, versus others where there is negotiation of the type described by the mutual agreement model described above.

Conclusion

In a model in which insureds and insurers take the drug monopolist's price as given and in which the drug seller takes insurance coverage as given, any Nash noncooperative equilibrium is one in which consumers are no better off with insurance than without. If consumers are sufficiently risk averse there may be no Nash equilibrium.

This paradox would not occur if buyers of insurance or sellers of the drug had foresight and took account of how choices of insurance coverage and drug prices interacted. If buyers are not too risk averse, drug sellers might set their launch prices a little below the equilibrium level, and then consumers would still demand insurance. If buyers are very risk averse, then even the existence of an equilibrium requires a more complex strategy involving a combination of a unit price and a coinsurance rate that gives consumers some advantage over having no insurance. This more complex strategy could also dominate even when consumers are not too risk adverse. If the drug firms take the lead, the outcome can be efficient, but the surplus goes to the drug firms. Consumers can do better if insurers take the lead. Either way, the coinsurance rate may be chosen based on the choice of formulary tier. In the more complex world of bargaining, the surplus can be divided between the drug seller and consumers.

Footnotes

[1] The assumption of constant MC rules out the model developed by Chiu (1997) based on increasing marginal cost of the insured good or service.   The model of Vathinathan (2006) of imperfect (Cournot) competition is ruled out by the assumption of simple monopoly pricing.

[2] We do not treat the case in which the insured is charged a fixed monetary amount per prescription (called in the US "copayment") or the case in which the insurance pays a fixed per unit indemnity usually linked to a reference price (confusingly labeled "copayment" by Cremer and Lozachmeur).

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