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The Australian Pharmaceutical Subsidy Gambit: Transmuting Deadweight Loss and Oligopoly Rents to Consumer Surplus

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Australia has long managed to pay pharmaceutical manufacturers substantially less for their products than other developed nations. Figure 7.1, based on data from the late 1970s, shows Australia paying prices substantially lower than those of ten comparison countries.[2] The average U.S. payment was 225 percent of the Australian average. In 1986–1987, the average global price of the eighty largest-selling drugs was 82 percent higher than that paid in Australia.[3] This pattern was remarkably consistent across drugs: about 90 percent had world average prices greater than the Australian price. Today, in most instances, Australian prices for patented medicines continue to be low relative to those of other Organisation for Economic Co-operation and Development (OECD) countries.[4]

Unlike most other developed countries, Australia does not regulate its drug prices directly. Any drug that meets Australian safety and efficacy standards can be marketed, and standards are administered without attention to the price of the drug.[5] Indeed, the prevailing legal view is that the Australian federal government lacks the constitutional power to regulate prices directly.

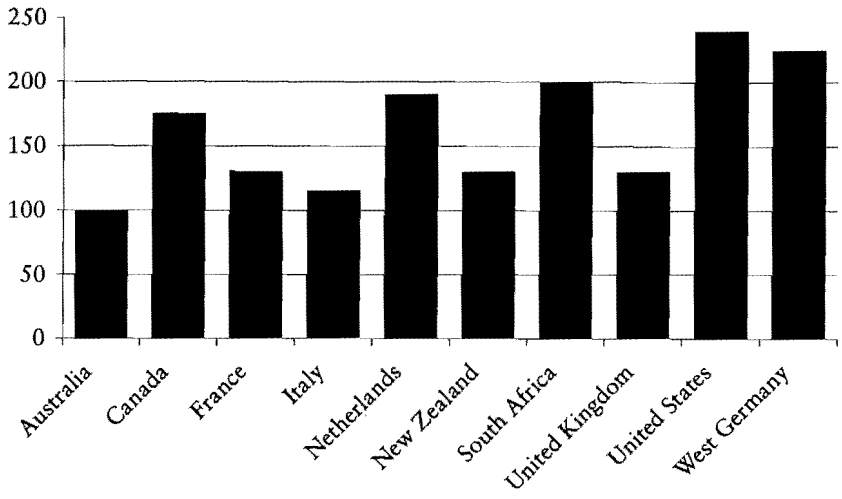
Australia's success does not depend on substantial purchases; the country represents only a small share of the world pharmaceutical market. How then has Australia managed to pay such low prices for its drugs?[6]

Australia's Price-contingent Subsidy Program

Australia's secret lies in a price-contingent subsidy program. Its government pays a per-unit subsidy to the drug producer—but only if the manufacturer and the government reach an agreement on the price. The program is a large one relative to Australia's gross domestic product (GDP).[7]

The essence of the Australian scheme is simple, and we have developed a model that captures its fundamentals. In the model's one-producer form, a monopolist is offered a per-unit subsidy if it will set the consumer price equal to the marginal cost. Sales increase substantially, and the subsidy allows the monopolist to earn slightly more than it would receive under monopoly pricing.

Figure 7.1 Manufacturers' Prescription Drug Prices, December 1977



Note: Australia = 100.

The deadweight loss of monopoly pricing is thus eliminated—transmuted into consumer surplus (save a smidgen for the manufacturer). In practice, Australia's arrangement is somewhat more complex, for three reasons: (1) it serves distributional goals beyond reducing the average price that Australians pay for drugs, (2) the government does not have full information about costs, and (3) its specific form reflects the tug-of-war inherent in the political process.

A subsidy scheme can provide a still more impressive feat of alchemy when more than one manufacturer is competing for a market—say, for statins. The government can play off one oligopolist against another, inducing a race to join the subsidy scheme. If Company A has joined the scheme and is therefore charging marginal cost, profits for Company B, at any price, will be much lower than at the initial oligopoly equilibrium—hence its incentive to join the scheme immediately. If both producers join the scheme, each is offered less than initial oligopoly profits.

Variants of this subsidy arrangement could be employed in any market where, because of market power, price significantly exceeds marginal cost. The subsidy scheme is particularly effective when producers are foreign, and the government's concern for their welfare is solely strategic (for example, it just wants them to remain in the market); their profits receive zero weight as a welfare consideration. To remove as much clutter as possible, we consider only the goal of increasing consumer surplus. We recognize that most subsidy schemes, including the Australian pharmaceutical subsidy arrangement, serve additional

purposes. To simplify, we shall assume away any externality, distributional, or merit-good arguments for consumption of the subsidized good.

The Australian government is engaged in an unusual form of a two-level game. By choosing an appropriate strategy in its domestic market, it substantially increases the benefits of its dealings with foreign producers. Domestic politics have frequently been manipulated (or misrepresented) to improve outcomes in international arenas.[8] Here that stratagem is extended to the microeconomic arena.

In considering consumer surplus we take research and development (R&D) expenditures by the manufacturer as a given. Schumpeter has launched a lively argument about the economics of invention, with some analyses (for example, Schumpeter 1975; Arrow 1962; Mansfield et al. 1977), emphasizing that invention is a collective good, while others (for example, Hirshleifer 1971; Loury 1979; Mortensen 1982) point to factors that encourage private firms to spend more on R&D than is socially optimal. For present purposes, however, we need not enter that debate since Australia comprises such a small proportion of the international pharmaceuticals market that its expenditure has a negligible impact on the level of international R&D. In contrast to most of the literature on technical innovation, we take an unashamedly single-country perspective.

There are good theoretical reasons for the success of the Australian scheme. Underpinnings for the case of the monopolist are reviewed in this chapter. We then show that, applied to an oligopoly, the subsidy scheme proves to be an ingenious real-world application of game theory. We then return to the Australian scheme and conclude.

Transmuting Deadweight Loss

We shall refer to the government as *A* and the producer as *B*. *A* wishes to subsidize *B*'s production in order to garner additional consumer surplus. But of course *A* must consider the cost of the subsidy. For the process of subsidization to be worthwhile, the gain in consumer surplus must exceed the cost of the subsidy. In deciding whether to undertake subsidies, therefore, the government needs to look at the net consumer surplus—what we shall call the *citizens' surplus*.

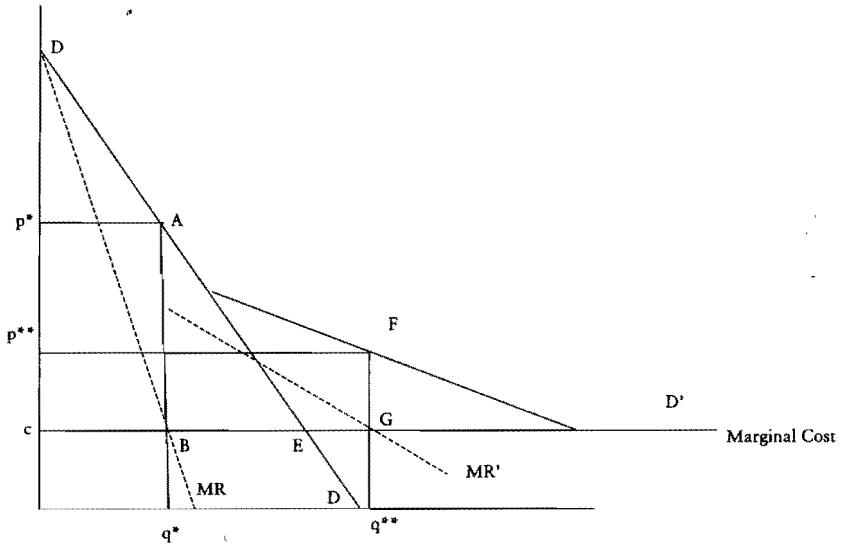
The Monopolist's Decision

Consider a monopolist, *B*, with no fixed costs and marginal cost (c), selling in a separable market offering the downward sloping demand curve DD, as shown in figure 7.2. The monopolist maximizes profits by setting marginal revenues equal to marginal cost at q^*, with resulting price p^*. The deadweight loss is the triangle ABE; profits are $ABCp^*$.

The knowledgeable government, *A*, looking out for all of its consumers, notices the divergence between price and marginal cost. Given prohibitions on

tariffs or price controls, it may try to remedy the situation by shifting out the demand curve. If the government adds some demand at relatively low prices, shifting the demand curve to *DD'*, the marginal revenue curve shifts to *MR'* once the new portion of the demand curve becomes relevant. Now marginal revenue and marginal cost are equated in two places. To choose between them, *B* will see which offers higher profits. In figure 7.2, *B* selects the lower-priced intersection and sets price at p^{**}, reaping the rectangle $FGCp^{**}$ as profit—an amount slightly greater than $ABCp^{*}$. Consumer surplus increases by the trapezoid under the original demand curve, bounded on top by p^{*} and on bottom by p^{**}.

Figure 7.2 Adding Demand to Lower the Price

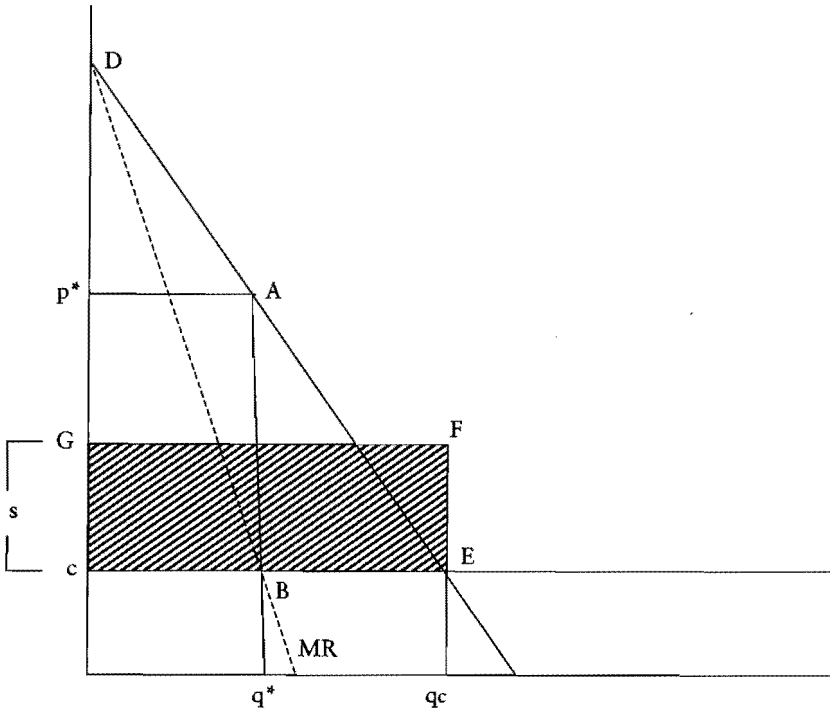


The scheme just outlined has one major disadvantage: the government ends up purchasing a considerable amount of the good. Presumably it can be resold, perhaps overseas, but not without financial loss and transactions costs. This problem can be avoided if *A* instead chooses to subsidize its own consumers as a mechanism for lowering price—it is their welfare, after all, that is to be maximized.

A straightforward, per-unit subsidy is likely to be most unattractive; it is both expensive and gives most of the subsidy to the producer. In figure 7.2, for example, the subsidy would have to raise the demand curve sufficiently to have the *MR* curve cut the cost curve at *E*. For this, a per-unit subsidy significantly greater than p^{*} would be required. Not only would this require a substantial government outlay, but the producer would capture the vast preponderance of the benefits.

To resculpt the firm's marginal revenue curve, shifting it out at low prices—but not at high prices—is a much more attractive option. Indeed, outward shifts at high prices are counterproductive. The simple way to accomplish the appropriate reshaping is to make the subsidy contingent on price, as is shown in figure 7.3.

Figure 7.3 The Subsidy that Maximizes Consumer Surplus



The government tells the manufacturer: "charge consumers marginal cost, and I shall pay you a per-unit subsidy equal to *s*." The diagram is drawn so that the subsidy offers just a smidgen more profit, the cross-hatched area, than *B* would reap by charging the original monopoly price. The net gain to the citizens equals the increase in consumer surplus ($AECp^{*}$), less the cost of the subsidy (*FECG*). Given that the subsidy offered to the producer is just a little more than the profit it could earn outside the subsidy scheme, the increase in citizens' surplus (the net gain in consumer surplus after paying the subsidy) will almost equal the original deadweight loss triangle. Deadweight loss has been transmuted to consumer surplus.[9]

If the government seeks to maximize citizens' surplus, the optimal price to charge consumers is the marginal cost of the good, whether marginal cost is constant or increasing. (In effect, the government is paying a lump-sum amount and then purchasing at marginal cost.) This assumes that no deadweight loss is associated with raising the funds to pay the subsidy. If there is such loss, the optimal price to consumers will be somewhat above the marginal cost (see Johnston and Zeckhauser 1991:9–11).

Transmuting Oligopoly Rents

Frequent rents are earned not by a monopolist but by an oligopoly that is able to exercise some market power. Under oligopolies, subsidy schemes cannot merely transmute the deadweight loss into consumer surplus but can also extract some of the rents, which can then be turned over to consumers. We consider a two-player oligopoly selling two differentiated products: each firm enjoys some degree of market power but each one finds demand influenced by the other firm's price as well as its own. For the sake of simplicity, we deal with two firms. They are engaged in Bertrand (price) competition, which captures our real-world situation much better than Cournot (quantity) competition. We shall assume Nash-equilibrium behavior, in which each player takes the other's behavior as fixed, rather than more collusive but more speculative equilibrium concepts.

The Duopolist's Decision

If we assume linear demand functions, the demand for firm i can be expressed:

$$q_i = a - bp_i + dp_j \quad (1)$$

where $0<b<d$ and p_j is the price charged by the other firm. Assume the firms have the same costs (a constant marginal cost of c) and demand. In the absence of collusion and with neither product subsidized, the firms could be expected to charge a price somewhere between the monopoly price and the competitive price— namely, the marginal cost. Though they compete, they have differentiated products. It is straightforward to derive the reaction function for each firm, assuming that it takes the other firm's price as given. The resulting Nash-equilibrium price for both firms:

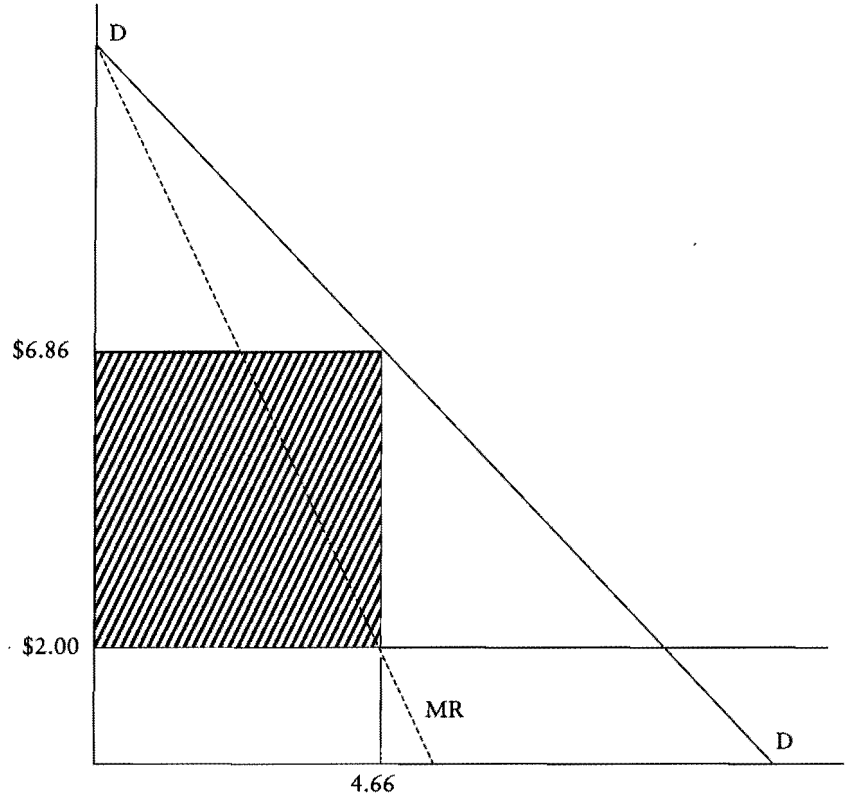
$$p_e = p_i = p_j = [a + bc]/[2b - d] \quad (2)$$

To illustrate, set $a_1 = a_2 = 10$ million, $b_1 = b_2 = 1$ million, and $d_1 = d_2 = 0.25$ million, with marginal cost assumed to be 2. The unsubsidized equilibrium p_1, p_2 pair has both prices set at \$6.86 (currency throughout is in Australian dollars). The optimization process for either firm, with its fellow duopolist's price at \$6.86, is shown in figure 7.4. Profits are equivalent to the shaded area in figure 7.4.

Subsidizing One Firm

Now let the government subsidize one of the firms, say Firm 1. Assume that the other firm does not react and that the price paid by consumers is set at the marginal cost of 2. To ensure that Firm 1's profit just exceeds its initial level would require a subsidy of a little over \$2.43 per unit. If Firm 1 were subsidized, of course, the other firm would lower its price in response, which in turn would reduce the profits of the subsidized firm.

Figure 7.4 A Duopolist's Outcome, Absent Subsidy



If the government decided in advance (and was committed) to subsidizing Firm 1 but not Firm 2, presumably the potentially subsidized firm would notice this chain of events looming and would demand a larger initial subsidy as a condition to participate in the scheme. The government must therefore offer Firm 1 a subsidy that is sufficient to offer profits at the new Nash equilibrium that just exceeds its Nash-equilibrium profits in the previously unsubsidized scheme.

We know the subsidized firm will be charging customers $2 for its product. The other firm, optimizing against this price of $2, will reduce its price by 61 cents to $6.25. If the first firm is to regain its presubsidy profits, it must be given a slightly larger subsidy of $2.47 for each of the units it sells.

Note that Firm 1 receives roughly the same profits as it did without the subsidy scheme. Firm 2, however, is now competing with a lower-priced firm and will sell less at any price; hence, Firm 2's profits will fall. Except in pathological cases, we would expect its optimal price to be somewhat lower than it was initially. In the example here, Nash-equilibrium profits for Firm 2 fall by 23 percent to $18.1 million.

Consumers gain in two ways. First, the reduction in the consumer price of the subsidized drug directly increases consumer surplus (in our example producing a net gain of $35.4 million). Second, the consequent reduction in demand for the second unsubsidized drug induces a voluntary price reduction (from $6.86 to $6.25 in our example). The resulting increase in consumers' surplus comes to $2.4 million in our example. The cost of the subsidy is $23.6 million, the old initial profits. The net result (after taking account of the direct cost of the subsidy) is therefore an increase in citizens' surplus of $14.2 million.[10]

The Subsidy Game

Selecting one firm to subsidize may not be optimal from the standpoint of the government or its citizens. Instead, the government can place the firms in a competitive situation, where each has the temptation to bolt the no-subsidy arrangement, though their joint profits will fall as soon as either bolts.

The interesting question then is what the first firm must be offered to participate, given the possibility that the government will entice Firm 2 into the subsidy scheme. In fact, as long as the firms are unable to collude, the government does not have to guarantee Firm 1 the full amount that it could earn were the scheme not implemented, because there is the risk that Firm 2 will participate and leave Firm 1 out in the cold.

Various structures might be considered for the subsidy offer. Consider five options:

(1) Subsidize only one firm to slightly increase its profit relative to the Nash-equilibrium profit when neither firm is subsidized.
(2) Offer to slightly increase the profit of any firm that bolts and takes the subsidy (again relative to the Nash-equilibrium profit).
(3) Subsidize, at the Nash-equilibrium level, any firm that bolts in the first round. Then subsidize the follower at a lower level that just exceeds the profits it could earn without a subsidy.
(4) Offer to subsidize either firm at the Nash-equilibrium level if it is the first to bolt, with the follower subsidized at a lower level just sufficient to induce it to opt in. If both bolt in the first round, subsidize only slightly above the level of profits each could earn without a subsidy, assuming the other were subsidized.
(5) Proceed as with 4, but offer the first bolter more than it would receive in the initial Nash equilibrium as a form of temptation.

Clearly, Option 1 would never be optimal for the government, given that citizens' surplus can always be increased by subsidizing the second product once the first is in the scheme.

Option 2 maximizes the sum of citizens' and producers' surpluses (given our initial assumption that direct price controls are not feasible). It does not reduce producers' profits and thus represents a Pareto improvement on the no-scheme situation. Such a scheme could be implemented with the full consent of the industry participants.

If the government wants only to maximize citizens' welfare or places greater weight on citizens than producers, it is better to drive a harder bargain with producers and pay a lower subsidy to a firm that does not participate immediately, giving it an incentive to join later. option 3 is designed on this basis.

Option 4 creates a "prisoner's dilemma" by offering the first bolter a tiny amount (ε) more than it would receive without the scheme. If both firms bolt simultaneously, each receives ε more than it would by not participating in the scheme, assuming the other *does* participate. Both firms have a dominant strategy to bolt at the outset.

It is by no means certain that option 4 will succeed in enticing the firms to bolt, especially if the game is expected to go on for some time. The firms may build up a trust relationship that enables them to resist the small, government-offered ε temptation to defect from the nonsubsidized equilibrium. But the government could inhibit the development of trust by how it structures the subsidy scheme, in particular negotiations with manufacturers.

Alternatively, the government might consider Option 5, which raises the payoff to the first bolter, which would then earn considerably more than it does at the initial equilibrium. When the reward for joining up first is large enough, the temptation to bolt or the fear that the other firm will is likely to lead both firms to bolt at the outset.

We have argued that a government seeking to maximize its citizens' surplus should capitalize on the subsidy game. Because each firm fears that the other might jump to embrace the scheme, both jump and each receives less than it did at the outset. Once one firm joins the scheme, the other will be given a small incentive to do so, though receiving slightly more than it would outside the scheme. All deadweight loss is eliminated. Equally important to a government that does not value firm welfare over citizen well-being, oligopoly profits are transmuted into consumer surplus.

The Scheme in Practice: Australian Pharmaceuticals

Our analysis has been concerned with a hypothetical market, hypothetical competitors, demand curves, and so on. We have shown how subsidies might be used to transmute deadweight loss and oligopoly profits to citizens' surplus. But economics is replete with optimal tax and subsidy schemes that will probably never be employed. Our interest in this scheme relates to its potential application in the real world in contexts where goods are priced considerably above the marginal production cost. We are encouraged by Australia's use of a fundamentally similar arrangement in an important policy context.

The extent to which a price-contingent subsidy can increase net consumer surplus depends on own- and cross-price elasticities of demand in a slightly complex fashion. Low own-elasticities imply that profits are high but deadweight loss is low. High cross-price elasticities boost the potential for playing firms against one another.

Historically, Australia chose an indirect approach to pharmaceutical price controls because its federal government was barred from direct price regulation. But its experience highlights some strong reasons for using a price-contingent subsidy even if direct price control is an option.

One consideration is the credibility of the government's threat not to subsidize a drug if the firm does not agree to the offered price. In general, the effectiveness of a threat depends not only on the penalty, but also on the probability that the threat will be carried out (Schelling 1960). The Australian government can afford to take a tougher stance in price negotiations because the manufacturer knows that even if it does not accept the government's price, the drug will still be marketed in the country through the private (unsubsidized) market and through state hospitals (where pensioners and low-income individuals, who might not be able to afford to purchase in the private market, have limited access). This possibility reduces both the manufacturer's and the government's losses if agreement is not reached. It also improves the government's bargaining position. For example, supplying only 10 percent of the potential market provides the firm with less than 10 percent of its potential profits (given start-up costs within Australia), but because the demand curve is falling, patients obtain substantially more than 10 percent of the potential consumer surplus.[11]

By contrast, in most other developed countries, drug prices are directly regulated and marketing approval is conditional upon agreement on price. The officials of such governments are in a much weaker position when negotiating the prices of new breakthrough drugs—a major concern for any policymaker. Officials must agree to the price before the drug can be made available to anyone in the country, and the manufacturers know this.

The effectiveness of Australia's indirect approach to regulating prices, in which marketing is not dependent on pricing agreement, hinges on:

- *The heterogeneity of patients.* The benefits of new drugs vary considerably across patients, with a relatively small proportion benefiting much more than the others (in economic terms, a steep demand curve).
- *The fixed costs that manufacturers face in marketing a new drug.* These include the costs imposed by national regulatory requirements and the higher costs associated with small production runs. The firms earn little, if any, profit if a new drug attracts only a small proportion of its potential market (in economic terms, a falling marginal cost curve—even for small quantities).
- *Limitations on the supply of unsubsidized drugs.* Typically only those who most need a drug will obtain it through state hospitals or the private prescription market. Inhibiting factors include the inconvenience and other indirect costs of obtaining the drug through a hospital, explicit rationing by the hospital, and the high price demanded for private prescriptions (including a higher retail markup).
- *An environment that discourages collusion.* Along with antitrust laws and the structure of the pharmaceutical industry, specific features of the subsidy arrangements make it unlikely that pharmaceutical manufacturers would collude to avoid a "prisoner's dilemma." (There is no evidence they have colluded in Australia.) The detailed procedures for approving new drugs for subsidy, including the discrete timing of approvals and confidentiality of applications, would undermine any cartel. A firm that chooses to renege on the agreement could easily get a big jump on a competitor. Most manufacturers have just one or a few big sellers, making the situation more like a one-play game. Promises of future reciprocity are unlikely to bind good behavior.

Because citizens with particularly pressing medical needs can obtain a drug even if its manufacturer refuses to reduce its price, the government is better able to weather any political storm that develops if a drug remains unsubsidized.[12] Otherwise, negotiators who refuse to subsidize a drug would risk very concentrated criticism and lobbying. As Olson (1968) points out, such concentrated interests often prevail over the diffuse interests of smaller players even though the latter's total stakes may be greater. Sales outside the subsidy arrangement thus serve as a safety valve.

A second advantage of the subsidy approach is reducing the adverse impact that price constraints might have on other sectors of the economy. Because Australia has always depended heavily on trade with the rest of the world, on foreign investment, and on technology imports, its government has been keen to maintain a reputation for stability and for respect of property rights. Australia is not a country where an investor's property is likely to be appropriated through

nationalization or, more indirectly, through such policy measures as price controls. The government is also eager to maintain its reputation with domestic investors, consumers, and voters.

By working through a subsidy program that is not billed as a price-control mechanism and by focusing on other program objectives—especially pensioner and low-income family access to needed medication—successive Australian governments have achieved powerful price leverage in the pharmaceutical market without causing unwarranted fear in other markets.

Conclusion

Like alchemy, the use of subsidies to increase economic efficiency is out of fashion. But we have demonstrated here how a price-contingent subsidy can be used to transmute deadweight loss (due to pricing above marginal cost) into consumer surplus. When more than one firm possesses market power, the subsidy can be used not only to boost efficiency but also to generate involuntary transfers. Oligopoly profits are turned into net consumer surplus. This transmutation is particularly beneficial if the subsidizer's only concern with producer profits is strategic. We believe that the subsidy arrangements discussed are worthwhile. And they may help to break down the solidarity of cartels.

In the 1970s and 1980s, Australia used a variant of this alchemy scheme to reap benefits equal to about 15 percent of its drug expenditures.[13] Though additional elements have been introduced, the central elements of that mechanism remain in use today. Australia (1) offers subsidies to provide firms with greater sales in exchange for lower prices and (2) allows sales of drugs outside the subsidized scheme as a "safety valve."[14]

In part, Australia's success may be due to the small size of its market and its geographical distance from most developed countries. Its transmutation of pharmaceutical profits to consumer surplus has had a negligible effect on global drug development, allowing Australia to meet the needs of its citizens with relatively little criticism.

Notes

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[2] The figure is based on data in Ralph et al. (1979), using prices of twenty-five branded products and sales weights in each country. The comparisons in the figure are consistent with figures published by the Australian Pharmaceutical Manufacturers Association (1978), which also showed prices in Belgium and Sweden to be 92 percent and 64 percent higher, respectively, than in Australia.

[3] From Parry and Thwaites (1988). The world average was based on developed countries for which data were readily available: Austria, Belgium, Canada, Finland, France, Italy, Japan, New Zealand, Spain, the United Kingdom, the United States, and West Germany. Although the eighty drugs were selected on the basis of Australian sales, the averages were calculated using local weights so that the world average reflects the relative use of those drugs overseas and the relative size of each national market. Prices are those paid to manufacturers. In these calculations, and throughout this chapter, the term *drug* refers to a specific chemical compound that may be marketed under more than one brand name.

[4] See Healy, Sharman, and Lokuge (2006), who draw on the Productivity Commission (2001) report. This is particularly true for "me-too" pharmaceuticals and generics, for which Australian prices are substantially below those of the United States, Canada, United Kingdom, and France—albeit similar to those of Spain and New Zealand (Duckett 2004, figure 7.2, p. 61, based on Productivity Commission 2001). We thank Karen Eggleston for guiding us to information on recent developments.

[5] Safety and efficacy standards are administered by a government agency that is quite distinct from the pricing agency (see chapter 6, Löfgren, in this volume). Perhaps more important, when decisions are based on marketing approval, the safety regulators are usually unaware of the prices that the manufacturers will seek.

[6] This is based on Johnston and Zeckhauser (1991) and data has not been updated. See that paper for further details of the economic theory underlying this presentation and for significant elaboration of its game-theory presentation.

[7] See chapter 6, Löfgren, in this volume.

[8] See Putnam (1988) for a discussion of how domestic politics influence international negotiations.

[9] In the pure monopoly case, *B* might hold out for a greater subsidy, especially if *A* did not have full information about *B*'s costs and the demand curve. In other words, *B* might demand a share of the gain in the consumer surplus. In the more realistic case of the oligopoly, however, the firm will be fearful of its competitors being subsidized and hence less likely to quibble.

[10] That is $14.2 = 35.4 + 2.4 - 23.6$—an uncompensated increase. Since prices are lower in the subsidized world, the value of the dollar is higher, which implies that the consumer surplus gains have been underestimated. On the other hand, no allowance has been made for the excess burden of taxation to be paid for the subsidy.

[11] Of course, if these sources comprised a major share of the market, the whole price-restraint mechanism would be undermined since manufacturers would have little incentive to participate in the scheme. But in fact, hospital and private market sales of unlisted drugs are only a small proportion of the market that can be achieved through the subsidy scheme.

[12] That the government's negotiators hold out and gamble on lower prices—offering the additional benefit of setting an example for other manufacturers—might be in the interest of other patients, but these benefits are diffused among many people, each of whom has little incentive to push the issue politically.

[13] See Johnston (1990).

[14] A major new element since the early 1990s is the use of cost-effectiveness in the pricing process. High prices are paid for innovative products, relatively low prices for less innovative products. A recent study by Roughead, Lopert, and Sansom (2007) finds that "Australian prices for medicines representing significant advances in therapy are similar to those paid under key U.S. programs" (p. 514).

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