Choosing the Right Battlefield for the War on Drugs: An Irrelevance Result

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Abstract

We describe a model where the effectiveness of a specific tax imposed by a government seeking to minimize consumption of some good is independent of whether the tax is imposed at the manufacturing or retail level.

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1 Introduction

A controversial issue in fighting the "war on drugs" has been the location of the principal enforcement effort by the US government. That is, would it be more cost-effective to attempt to interdict drug supplies at their source, principally in Colombia, or would efforts be better placed in local drug enforcement efforts, such as the three strikes rule and the like. In practice, the US government has chosen to undertake both approaches simultaneously, but it is not clear that such a diversified approach is either warranted or especially effective.

In this paper, we model the market for illegal drugs as one characterized by double marginalization (see Gal-Or (1991), Spengler (1950) and Tirole (1990)). Specifically, an upstream monopolist, such as a drugs cartel, sells wholesale quantities of drugs to local distributors in the US, who we model as Cournot competitors. The local distributors (hereafter "downstream firms") then "cut" the wholesale package into smaller amounts for retail sale. We imagine that the US government has the objective of minimizing the quantity of retail drugs consumed by its citizens and that it can impose quantity taxes on the upstream and the downstream firms. These taxes are meant to act as a proxy for interdiction and enforcement efforts which effectively raise the production costs at the upstream (downstream) levels. Thus, we model the market for drugs as a stage game involving the US government, the upstream monopolist, and the downstream oligopolists and consider the location of optimal enforcement efforts the US.[1]

The volume and seriousness of the drug problem make the question of optimal enforcement inherently worthy of study. Moreover, the controversy and disagreement between the two main approaches suggests that the proper enforcement strategy is by no means obvious to policy makers. In this light, our analysis represents an (admittedly crude) first attempt at considering the fundamental economic forces underlying the enforcement decision in the context of a strategic game.[2] Surprisingly, we find that in our simple model the location of enforcement effort is irrelevant to the quantity minimization problem. From this, we conclude that the choice of battlefield on which to fight the war on drugs is likely to be of only secondary importance in choosing effective anti-drugs policy.

2 The Model

Consider a market for drugs with an inverse demand curve given by

$$p(Q) = f(Q) \tag{1}$$

[1]A related paper is Spencer and Jones (1991) who consider vertical production in international trade settings.

[2]Fowler (1996) also examines interdiction efforts in a dynamic framework.

where Q denotes the total quantity of the good consumed in the market and p denotes its price. We assume $f'(Q) < 0$.

Suppose that this market is served by n identical retail firms which compete in a Cournot fashion. Suppose that these firms must all purchase an intermediate good, x, from an upstream monopolist. The retail firms then convert the intermediate good at a cost $C_r(q(x_i))$ where $q(x_i)$ represents the *wholesale-retail transformation technology.* We assume that the upstream monopolist has no power to price discriminate among the retailers; thus, each retailer pays P^m for each unit of the intermediate good purchased. Finally, suppose that the government imposes some specific tax t^r on each unit of the final good sold. Then the ith retail firm's problem is:

$$\max_{x_i} \left\{ q(x_i) \left[f(\sum_{j=1}^{n} q(x_j)) - t^r \right] - P^m x_i - C_r(q(x_i)) \right\} \tag{2}$$

Suppose that the upstream monopolist manufactures an intermediate good at a cost $C_m(X)$ where $X = \sum_{i=1}^{n} x_i$. It sells this good to the retail firms but such sales are subject to a specific tax t^m on each unit of the intermediate good sold. Thus, the upstream monopolist's problem is:

$$\max_{P^m} \left\{ \sum_{j=1}^{n} x_j(P^m) \left[P^m - t^m \right] - C_m(\sum_{j=1}^{n} x_j) \right\} \tag{3}$$

Finally, the government is trying to minimize consumption of the good and has the ability to place a specific tax of t per unit on either the upstream monopolist or the retail firms. The government thus wishes to optimally choose the placement of the tax.

Extensive Form

We consider the following extensive form game describing the interaction of the government, the upstream monopolist, and the retail firms. In the first stage of the game the government decides where to deploy its tax, either on the monopolist or the retail firms. In the second stage, the monopolist chooses its price, P^m and sells some quantity of the intermediate good to each of the retail firms. In the third stage of the game, the retail firms simultaneously choose x_i and sell their goods at the equilibrium price given by the inverse demand curve.

We solve this game using backward induction. In the third stage of the game, we will restrict attention to the symmetric pure strategy equilibrium choices of x_i by each of the retail firms.

3 Equilibrium Analysis

We suppose that the retail firms convert the wholesale good on a one-for-one basis to produce the final good which is sold to the consumers. That is, assume that $q'(x_i) = 1$, $q'' = 0$ for all x_i. Thus, the problem reduces to firms simply choosing q_i.

In the third stage of the game, each firm faces the following problem:

$$\max_{q_i} \left\{ q_i \left[f(\sum_{j=1}^{n} q_j) - P^m - t^r \right] - C_r(q_i) \right\} \tag{4}$$

Differentiating with respect to q_i yields:

$$f(\sum_{j=1}^{n} q_j) - P^m - t^r + q_i f'(\sum_{j=1}^{n} q_j) - C_r'(q_i) = 0 \tag{5}$$

imposing symmetry, $q_i = q_j = q$, the symmetric equilibrium solves:

$$f(nq) - P^m - t^r + qf'(nq) - C_r'(q) = 0 \tag{6}$$

We now consider the second stage of the game. The upstream monopolist's problem becomes:

$$\begin{aligned} &\max_{Q,P^m} \left\{ Q\left[P^m - t^m\right] - C_m(Q) \right\} \\ \text{subject to} \quad & f(Q) - P^m - t^r + \tfrac{Q}{n} f'(Q) - C_r'(\tfrac{Q}{n}) = 0 \end{aligned} \tag{7}$$

Letting λ be the Lagrange multiplier associated with the constraint and differentiating with respect to P^m and Q respectively yields:

$$Q - \lambda = 0 \tag{8}$$

and

$$P^m - t^m - C_m'(Q) + \lambda \left(f'(Q)(1 + \frac{1}{n}) + \frac{Q}{n} f''(Q) - \frac{1}{n} C_r''(\frac{Q}{n}) \right) = 0 \tag{9}$$

Substituting for λ and P^m in (9) yields:

$$f(Q) - t^r + \frac{Q}{n} f'(Q) - t^m - C_m'(Q) + Q\left(f'(Q)(1 + \frac{1}{n}) + \frac{Q}{n} f''(Q) - \frac{1}{n} C_r''(\frac{Q}{n}) \right) = 0 \tag{10}$$

Definition 1 *Let*

$$\begin{aligned} \phi(Q; t^t, t^m, n) \quad \equiv \quad & f(Q) - t^r + \frac{Q}{n} f'(Q) - t^m - C_m'(Q) + \\ & Q\left(f'(Q)(1 + \frac{1}{n}) + \frac{Q}{n} f''(Q) - \frac{1}{n} C_r''(\frac{Q}{n}) \right) \end{aligned} \tag{11}$$

Now, observing ϕ simply depends on the sum of t^r and t^m, the following is immediate.

Proposition 2 *A quantity minimizing government is indifferent as to whether to a specific tax of t levied on the upstream monopolist or the retail firms.*

Since for a given tax level, the same quantity is produced, then it is obvious that to generate a given level of tax revenues, the location of the tax is irrelevant. The corollary then readily follows:

Corollary 3 *Given a tax level $\bar{t}$, an upstream tax is revenue equivalent to a downstream tax.*

Example

The economic intuition for these results is easiest to see for the case where $n = 1$ and all costs of production are zero, i.e. the classic double marginalization problem. Here, the derived demand curve faced by the upstream monopolist is given by the market marginal revenue curve less any tax on the retail firm, in this case,

$$P^m = f(Q) + Qf'(Q) - t^r \tag{12}$$

Thus, the upstream monopolist sets the marginal revenue associated with the derived demand curve equal to his marginal cost, in this case, the tax on the upstream monopolist

$$f(Q) + 3Qf'(Q) + Q^2 f''(Q) - t^r = t^m \tag{13}$$

Now, it is immediately obvious that the two taxes are perfect substitutes in that we can rewrite this equation as:

$$f(Q) + 3Qf'(Q) + Q^2 f''(Q) = t^m + t^r \tag{14}$$

Thus, Q is determined only by sum of the specific taxes imposed independent upon whom the taxes are levied. This is because a tax on the retailers shifts the demand curve (and the resulting marginal revenue curve) down by t; whereas the tax on the upstream monopolist shifts his marginal costs up by t, but these two effects are exactly the same.

Comments

Crucial to the irrelevance result is the assumption that wholesale quantities are transformed at the retail level on a one-to-one basis. Nonetheless, the result is suggestive of the fact that for transformation technologies where additional production at the retail level is unimportant, the location of interdiction efforts is likewise unimportant in determining effective policy.

References

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