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Continuous Optimization

The double marginalization problem of transfer pricing: Theory and experiment

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ABSTRACT

In this paper, we find that the idea of using optional two-part tariffs as a basis for tariff renegotiations in a bilaterally monopoly setting is a solution to the double marginalization problem that theoretically (1) creates a stable equilibrium, (2) at the overall efficient level, (3) without the presence of a central management. Through experimental testing, we find that the efficiency of this mechanism is significantly higher than the efficiency of simple direct negotiation, both under symmetrically and asymmetrically distributed information.

1. Introduction

The general double marginalization problem refers to the fact that the actors in a bilateral monopoly setting will reduce their combined profit by simultaneously exercising their market power against each other, compared to a situation where the actors are vertically integrated. This problem can be traced back to Cournot (1838), even though Edgeworth (1889) and Pareto (1896) probably were the first to provide formal analysis of the problem. The basis of the problem is that, compared to the perfect competition price-quantity solution (or the vertically integrated solution), a classical monopolistic seller wants to reduce the quantity transferred in order to increase the price, while a classical monopsonistic buyer wants to reduce the quantity transferred in order to decrease the price. But if no actor can dictate the price, this actually results in two distinct problems: (1) there is no stable equilibrium on the market, which means that the actors will have to negotiate price and quantity; (2) the negotiation is likely to result in an inefficient solution, since both actors were trying to reduce the quantity in the first place.

The problem of double marginalization has been discussed in several settings, beside the pure economic bilateral monopoly context. For example, Jeuland and Shugan (1983) analyze how distributions channels can be coordinated and suggest, e.g. joint ownership, profit sharing or quantity discounts as possible ways to deal with the double marginalization. However, neither of these suggestions actually solved the two distinct problems.

Another application is made by Economides (1999), who analyzes how quality is affected in a bilateral monopoly setting. He concludes that the double marginalization creates a situation where "...independent vertically-related (disintegrated) monopolists will provide products of lower quality level than a sole integrated monopolist" (Economides, 1999). But no solution to the problem was provided.

Yet another setting where double marginalization has been a major issue is the transfer pricing context. For example, Ronen and McKinney (1970) acknowledged the Hirshleifer (1956) proposition that an optimal transfer price must reflect the seller's marginal cost, but claimed that dual pricing with support from a central administration was necessary in order to make the marginal cost solution an equilibrium (i.e. in order to remove the problem of double marginalization). This model, however, requires the presence of a central management and is sensitive to asymmetric information since it does not remove the incentive for the actors to provide false information during the process of determining the pricing structure.

The literature on the double marginalization problem and proposed solutions to it is rather extensive (see, e.g. Rey and Vergé, 2005; Tirole, 1988) but the only proposed solution that (1) creates a stable equilibrium (2) at the overall efficient level (3) without the presence of a central management at some point in the process seems to be the bilaterally optional two-part (BOT) tariff model suggested by Lantz (2000).[1] The basic idea is to use the current two-part tariff as a "threat tariff" à la Sibley (1989) in the negotiations (the model was presented in a transfer pricing setting) for a new two-part tariff. Either the buyer or the seller can propose a change in the present two-part tariff at any time and for any reason, but if the counterpart does not accept that proposition the present tariff remains unchanged. The logic is that the model by definition

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[1] A two-part tariff is defined as a pricing principle where the price of a product or service is composed of two parts – a lump-sum fee ("the fixed part") and a per-unit charge ("the variable part").

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prevents any actor from exploiting the other, since either both actors gain from a tariff change, or no one increases profit from keeping the old tariff.

Exactly the same idea was presented later by Cheng (2002) as "a breakthrough in transfer pricing", even though he denoted the fixed part of the tariff "an option". However, neither Lantz (2000) nor Cheng (2002) provide a formal analysis of the model, and even though Lantz (2000) does provide some empirical evidence, it is not really conclusive. The purpose of this paper is to provide a formal analysis and the results of an experimental test of this mechanism.

The remainder of the paper is organized as follows. Firstly, there is an analytic section where the properties of a direct negotiation (DN) in a standard bilateral monopoly setting under no regulation and under the BOT model, respectively, are derived. The main claim here is that BOT actually does provide incentives for the seller and the buyer to autonomously find the overall efficient solution in the negotiations. Then the experimental design is discussed, and the results from the experiments are presented. The main claim of this section is that the BOT model provides significantly better incentives than DN, both under symmetric and asymmetric information. Finally, there is a short discussion which concludes the paper.

2. The direct negotiation model and the bilaterally optional two-part tariff model

Under DN, we assume that we have one seller and one buyer in a bilateral monopoly setting, where both want to maximize their individual profit are about to determine short term price and quantity for the good in question. Throughout the paper, we will use these definitions:

- f_t is the fixed part of a two-part tariff (where applicable) in period t;
- p_t is the variable part of a two-part tariff (where applicable – or else the standard linear price) in period t;
- $q(p_t)$ is the quantity in period t;
- $c(q(p_t))$ is the seller's total cost function in period t;
- $r(q(p_t))$ is the buyer's net total revenue function in period t;
- p^* is the overall efficient level of p, i.e. where $r'(q(p)) = c'(q(p))$.

We assume that the functions $c(q(p_t))$ and $r(q(p_t))$ are suitably smooth and twice continuously differentiable and that $c''(q(p_t)) \leqslant 0$ and that $r''(q(p_t)) \geqslant 0$ for all q. Note that $q(p_t)$ will coincide with $r'(q(p_t))$ when $p_t \geqslant p^*$ and with $c'(q(p_t))$ when $p_t \leqslant p^*$.

Proposition 1. Profit maximizing behaviour leads to a situation where efficiency is reduced compared to the overall efficient solution.

Proof. The seller's decision problem is

$$\text{maximize } p_t q(p_t) - c(q(p_t)), \tag{1}$$

which has the solution

$$\frac{\partial[p_t q(p_t) - c(q(p_t))]}{\partial p_t} = 0, \tag{2}$$

which yields

$$p_t = c'(q(p_t)) - \frac{q(p_t)}{q'(p_t)}, \tag{3}$$

which is equivalent to reducing quantity from the overall efficient level by using a monopoly mark-up on marginal cost (since $q(p_t)/q'(p_t) < 0$ by definition).

Analogously, the buyer's decision problem is

$$\text{maximize } r(q(p_t)) - p_t q(p_t), \tag{4}$$

which has the solution

$$p_t = r'(q(p_t)) + \frac{q(p_t)}{q'(p_t)}, \tag{5}$$

which is equivalent to reducing quantity from the overall efficient level by using a monopsony "mark-down" on net marginal revenue.

The problem, of course, is that both actors in the above analysis assume that the opponent does not exercise his market power. Yet, it is easy to see that the dominant strategy for both actors is to try to use their market power no matter what the opponent does. In a game setting, there are four possible outcomes. There are two actors, and both can choose to exercise market power or not exercise market power.

For each actor, we rank the outcomes from 1 to 4 in terms of profit. The best outcome for either actor is the monopoly/monopsony position, which is reached if one actor exercises market power while the other one does not. This is of course also the worst outcome for the other actor. The second best is the perfect competition solution, which is reached if neither actor exercises market power. The third best solution (which is indeterminate, but generally better than being subject to the other actor's market power, but also worse than the perfect competition solution) is reached when both actors try to exercise their respective market power simultaneously.

		Seller	
		Does exercise market power	Does not exercise market power
Buyer	Does exercise market power	S: 3rd B: 3rd	S: 4th B: 1st (monopsony)
	Does not exercise market power	S: 1st (monopoly) B: 4th	S: 2nd B: 2nd

From the above table, it is easy to see that the dominant strategy for both actors is to exercise market power no matter what the other actor does. Thus, the equilibrium (though indeterminate in terms of price and quantity) is that both actors try to exercise market power. □

Under BOT, the seller and the buyer are both assumed to maximize their individual profit, to reject any suggested tariff change that will lead to lower individual profit compared to the present tariff, and only to suggest tariff changes that will lead to a higher individual profit compared to the present tariff. Thus, the sellers's decision problem is

$$\begin{aligned} &\text{maximize} && p_t q(p_t) + f_t - c(q(p_t)) \\ &\text{subject to} && p_t q(p_t) + f_t - c(q(p_t)) \geqslant p_{t-1} q(p_{t-1}) + f_{t-1} - c(q(p_{t-1})) \\ &&& r(q(p_t)) - p_t q(p_t) - f_t \geqslant r(q(p_{t-1})) - p_{t-1} q(p_{t-1}) - f_{t-1}. \end{aligned} \tag{6}$$

Under symmetric information, the seller is aware of the fact that the buyers's decision problem is

$$\begin{aligned} &\text{maximize} && r(q(p_t)) - p_t q(p_t) - f_t \\ &\text{subject to} && r(q(p_t)) - p_t q(p_t) - f_t \geqslant r(q(p_{t-1})) - p_{t-1} q(p_{t-1}) - f_{t-1} \\ &&& p_t q(p_t) + f_t - c(q(p_t)) \geqslant p_{t-1} q(p_{t-1}) + f_{t-1} - c(q(p_{t-1})). \end{aligned} \tag{7}$$

The situation facing the buyer is of course simply the reversed one.