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International Journal of Industrial Organization  
22 (2004) 737–757

International Journal of  
Industrial  
Organization

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# Nonlinear price discrimination with a finite number of consumers and constrained recontracting

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Available online 28 May 2004

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## Abstract

In the monopoly nonlinear pricing problem with unobservable consumer types, we study mechanisms in which the firm makes the set of consumer options conditional on the aggregate reports of consumer types it receives. Previous mechanisms that exploit knowledge of the true type distribution often have multiple equilibria or use noncredible contracts off the equilibrium path. When the monopolist can replace contracts after initial reports subject to the constraint that truthful consumers are not made worse off, the outcome is essentially the same as when the monopolist has full information. This holds whether or not the monopolist can make offers to consumers who reject all original contract offers. When the monopolist must guarantee nonnegative surplus to all truthful consumers in all contingencies, the equilibrium outcome has undistorted contracts but lower profits for the monopolist.

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*Keywords:* Equilibrium path; Monopolist; Consumer types

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## 1. Introduction

The best modern interpretation of second-degree price discrimination (or declining-block pricing) is that it arises as the solution to an asymmetric information problem. The monopolist knows the distribution of consumer types but cannot identify demand curves of individual consumers. While the monopolist takes the distribution of consumer types into consideration in choosing the optimal schedules, it does not use this information about market aggregates as aggressively as possible. In particular, the conventional solution has

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the monopolist choosing the nonlinear pricing schedule subject to incentive compatibility constraints (so that each consumer would truthfully reveal his type to the monopolist), but the contracts offered do not depend on the number of consumers who request each of the contract choices. One justification for this approach is that the monopolist is assumed to be selling to a large (infinite) number of consumers.<sup>1</sup>

An alternative assumption that we explore in this paper is that the monopolist has a small (finite) set of potential customers and knows the exact distribution of types. With precise information on the number of each type of consumer in the market, the monopolist can detect that some consumers seek to pay a lower average price per unit by reporting that they prefer a smaller quantity than they actually do. Using this information significantly changes the nature of the monopoly's optimal pricing policies.

Each of these specifications is most appropriate in different contexts. The standard model may best fit a final good monopolist selling to a large number of individuals. Even though this number is still finite, uncertainty about the exact distribution of types can smooth things out, making a model with a continuum of consumers appropriate. On the other hand, an intermediate good monopolist may sell to a small number of oligopolists and, through access to general market research, may have reasonably precise information about the distribution of types to whom it is selling.

Previous models have exploited the seller's information about consumer aggregates in a variety of ways. In a perfect information setting, [Levine and Pesendorfer \(1995\)](#) allow a monopolist to precommit to a pricing strategy in which no sales take place if any consumer chooses to purchase less than the quantity which yields zero surplus to the consumer. They also show that such an equilibrium is not robust to the introduction of noise in players' actions.

[Bagnoli et al. \(1989\)](#) consider a durable-good monopoly and find that the monopolist can extract all surplus by making a sequence of price offers which depend on the history of purchases. This equilibrium is subgame perfect, but not unique.<sup>2</sup> [Bagnoli et al. \(1995\)](#) study a similar mechanism in a model of quality differences and find the monopolist can extract all surplus. We discuss the differences between their mechanism and ours in the conclusion.

With asymmetric information, the idea that correlation between consumer types may help a monopolist extract additional surplus from consumers has been studied elsewhere, especially in auctions. In fact, [Cr mer and McLean \(1985, 1988\)](#); [Brusco \(1998\)](#), and [Spiegel and Wilkie \(2000\)](#) develop mechanisms by which the seller can extract the full surplus under certain conditions. [Fudenberg and Tirole \(1991, pp. 294–295\)](#) discuss the fact that these mechanisms may require large payments by consumers in certain outcomes of the game. Our correlation among types is a special case of the distributions studied by Cr mer and McLean because the aggregate distribution is common knowledge among consumers and the firm. However, our mechanism bounds the losses to agents in outcomes off the equilibrium path and some of our assumptions are more general. We discuss differences between these models and ours more fully in the final section.

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<sup>1</sup> With a continuous distribution of types, [Hammond \(1979\)](#) shows that one cannot improve on such a solution by conditioning one types payments on the reports of other types.

<sup>2</sup> While other equilibria are not considered in the paper, it is clear that Coase's solution remains an equilibrium of the game.

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