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# Adverse selection without single crossing: Monotone solutions

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## Abstract

The single-crossing assumption simplifies the analysis of screening models as local incentive compatibility becomes sufficient for global incentive compatibility. If single crossing is violated, global incentive compatibility constraints have to be taken into account. This paper studies monotone solutions in a screening model that allows a one-time violation of single crossing.

The results show that local and non-local incentive constraints distort the solution in opposite directions. Therefore, the optimal decision might involve distortions above as well as below the first-best decision. Furthermore, the well-known “no distortion at the top” property does not necessarily hold. The results show that the decision can even be distorted above first best for all types. Sufficient conditions for existence, (strict) monotonicity and continuity of the solution are presented. A new necessary condition satisfied by such solutions is found. An algorithm based on this condition can calculate continuous and strictly monotone solutions.

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## 1. Introduction

Screening models are among the most commonly used tools in microeconomics. In these models, a principal offers a menu of contracts from which an agent with private information about his “type” chooses his preferred option. Depending on the application, the type represents the production technology of a firm in models of regulation (Baron and Myerson, 1982; Laffont and Tirole, 1987), the productivity of a worker in an employment relationship (Guasch and Weiss, 1981) or the willingness to pay for a product in models of monopoly pricing (Mussa and Rosen, 1978).

In all these applications, the authors assume single crossing (SC)<sup>1</sup>: types can be ordered according to their marginal rate of substitution between money and the decision, e.g. the quantity purchased in a monopoly pricing problem or the quantity produced in a regulation setup. With the commonly used quasilinear preferences, SC is equivalent to a type ordering according to marginal utilities/costs; e.g. a higher type has a higher marginal utility at every consumption level. The private information of an agent is then his eagerness to consume more.

While SC is a technically convenient assumption, we can think of many unobserved differences other than eagerness/efficiency. Some people are very eager at first but quickly get saturated while others have more steady preferences. Compare, for example, single-person households with families. At low quantities, single persons might have a higher marginal willingness to pay for standard groceries because of a higher income per household member. At high quantities, however, families will have the higher marginal willingness to pay as single persons are already saturated. This violates SC: household types cannot be ordered according to their marginal willingness to pay.

As a second example, take firms with private information about their production technology. A capital-intensive, fully-automated production facility will – at normal output levels – have lower marginal costs than a labor-intensive technology. But as soon as quantity approaches the capacity level of the capital-intensive facility, the labor-intensive production technology could have lower marginal costs.

This paper analyzes a screening model in which SC is violated. Agents have quasilinear preferences and a one-dimensional type. SC would require a constant sign of the cross derivative of the agent’s cost function with respect to type and decision. By contrast, my setting allows for a one-time violation of SC: the type versus decision plane is separated by a strictly increasing function  $s$  into two regions. The cross derivative is negative above  $s$  and positive below  $s$  (see Fig. 1).

The revelation principle implies that implementable menus of contracts can be viewed as mechanisms in which the agent is induced to truthfully reveal his type. Put differently, the menu must be incentive compatible. With SC, the local first- and second-order conditions of the agent’s maximization problem (maximizing utility over his type announcement) are necessary and sufficient for incentive compatibility. Without SC, these first- and second-order conditions are necessary but not sufficient for incentive compatibility.

Incentive compatibility requires the optimal decision function  $q(\theta)$  to be increasing (decreasing) whenever  $c_{q\theta}(q(\theta), \theta) < (>)0$  and  $q$  is continuous at  $\theta$ . A continuous optimal decision function (decision as function of type) will therefore be either inversely U-shaped or monotone. Araujo and Moreira (2010) analyze solutions in which the decision function is inversely

<sup>1</sup> Other names for this assumption include “Spence–Mirrlees” or “constant sign” condition.

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