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# Mixed Versioning of Information Goods Under Incomplete Information

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## Extended Abstract[1]

## INTRODUCTION

Information goods such as computer software or electronic newspapers can be provided by firms at a low marginal cost, while in many cases large capital outlays are required to produce their first unit. The substantial setup cost is thereby mainly driven by the cost of developing the top quality product. Having established this "flagship" product, a firm can degrade it or in other ways modify it, and in this way create a multitude of products at a small "versioning" cost. Finding *optimal* versioning strategies for information goods is becoming increasingly important for Internet commerce, as low distribution costs and newfound customer intimacy render intricate second-degree price discrimination strategies feasible.

## THE MODEL

We present a model of a firm that chooses a two-product portfolio sequentially. The firm determines its second or *versioned product* after it has completed the development of its *flagship product* and uncertainty over the market acceptance of the latter has resolved. The demand for the information goods considered here is supposed to be discrete. In other words, once a product is offered at or below the reservation price of a consumer, she may decide to buy exactly one unit of it. When confronted with a choice between different products, the consumer naturally prefers a product that achieves maximum utility, attaining highest affordable quality, which at the same time is "close" enough to her taste. If the sum of the utility for this product and the utility for the remaining wealth is below the utility for the initial wealth, the consumer decides not to buy anything. More specifically, all consumers are initially endowed with a wealth level and a taste. Each consumer of a certain (taste,wealth)-type has a utility, which depends on price, product quality, and distance of the horizontal product characteristic from their own taste. Quality is thereby a vertically differentiating criterion and can be thought of as performance and/or product breadth or depth. The quality level is assumed to induce a preference ordering among products of equal price, while taste or horizontal product characteristic is just a coordinate in product space that makes a good more attractive to consumers that are "located" sufficiently close.

Given a distribution of consumer types (here assumed to be uniform for simplicity), generated for instance by usage preferences or existing standards, the firm can choose product characteristics so as to attract as many of the consumers with sufficiently high income (i.e., potential buyers) as possible. Such versioning is consistent with the fact that information goods can be quite easily repackaged and reconfigured once a modular structure of features has been established. The goal of the risk-neutral multiproduct firm is to create a certain number of product offerings (here at most two to keep complexity low), consisting of tupels of the form *product offering* = (*price, quality, horizontal product characteristic*), such that expected profits are maximized. Each product offering targets a certain subset or *segment* of the (taste,wealth)-space, into which the consumers self-select by choosing the product that maximizes their respective utilities. However, the firm's ability to optimize the choice of its portfolio is limited by imperfect information about the consumer characteristics at the outset. This uncertainty gets resolved after the creation of its

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flagship product as it typically can be used to evaluate demand. Now, given the flagship product and complete information about the consumers, the versioned product can be chosen optimally.

In the line of work on second-degree price discrimination of multiproduct firms and their product line extensions, Jones and Mendelson (1998) show that for quality-differentiated information goods and a uniform distribution of consumer types, no differentiation is optimal.[2] Our results in this paper do not confirm these findings interpreting the type parameter as reservation price, which induces an additional feasibility constraint (no consumer can pay more than her reservation price), and this in turn yields a stable separation of the consumer base.

# RESULTS

In the case of perfect market information, we show that, even when firms can customize their product to different tastes and vary product quality simultaneously, it may never be optimal to do both at the same time. This suggests that in many cases it is sufficient to examine vertical and horizontal differentiation strategies separately in theoretical work. It also suggests that in determining an optimal pricing strategy, firms need only consider the best pure horizontal differentiation strategy and the best pure vertical differentiation strategy to decide which strategy to pursue; there is no need to consider mixing. The intuitive reason is that mixed versioning can only occur as an interior optimum that under perfect information can be improved upon by, depending on the versioning costs, either separating the products horizontally (no cannibalization) offering the same quality to both market segments or inducing a stable vertical segmentation offering two products of the same horizontal taste at different pricepoints and qualities. The latter segmentation is stabilized by the introduction of a (justified) feasibility constraint that has been omitted by earlier work in the area.

On the other hand, in the situation where uncertainty about consumer characteristics is resolved gradually, mixed differentiation may indeed be an *optimal* reaction to an imperfect choice of the first product. However, the resulting product portfolio may be such that only one product has positive sales, which in some sense confirms the suboptimality of mixed differentiation in the perfect information case.

From the managerial point of view, our results help to clarify that the function of mixed differentiation can be to "salvage" an imperfect first-period positioning of a flagship product, especially in the case when *ex post* modification of the flagship product's attributes is prohibitively expensive. In the case of perfect information about the consumer base, mixed versioning is typically not efficient and it may be best, depending on the (linear) cost of quality $\beta$, to either purely vertically differentiate product versions (low $\beta$), to purely horizontally differentiate while minimizing product cannibalization (medium $\beta$), or not to enter at all (high $\beta$). Either one of these "pure" strategies is likely to dominate mixed versioning.

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[2]These results have been recently generalized by Bhargava and Choudhary (2001). They give sufficient conditions for goods with nonzero marginal costs and general utility functions under which a stable, incentive-compatible separation of the consumer base into segments can be reached.

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