



Can online markets attract high-quality products?☆



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ABSTRACT

We study a firm's choice between online and physical markets with respect to product quality. We analyze two contrasting driving forces: On the one hand, online consumers cannot physically inspect the products prior to purchase. This provides the firm with the incentive to hide low-quality products online. On the other hand, consumer reviews and the larger market size may attract higher qualities to the online market. Using a simple yet flexible framework, we show that the firm's choice of a marketplace can disclose or hide product quality. If marginal cost is convex in quality, the firm's choice will be characterized by a cut-off quality level, below which the firm will choose the online market. If marginal cost is concave in quality, both high-end and low-end qualities may choose the online market, leaving the physical market to intermediate qualities. Overall, we show that consumer reviews can alleviate, but do not eliminate, the "lemons problem". The pooling result in the case of concave-in-quality marginal cost provides a caveat for empirically testing the effectiveness of online consumer-review mechanisms.

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1. Introduction

The fast growing e-commerce has drawn increasing attention from researchers and policy-makers. Among the recent studies, one stream of literature is focused on the relation between online and physical markets.¹ While most of the previous studies assume that firms' marketplaces are exogenous to product quality, in this paper we relax this assumption and study a firm's choice between online and offline markets with respect to quality.

We analyze two driving forces behind a firm's market choice: On the one hand, when consumers buy goods such as toys, clothing, and furniture from an online market, they cannot inspect the product's quality prior to purchase. In such cases what is usually regarded as a search

good in a physical market is, at least partially, turned into an experience good in the online market. This gives rise to the possibility of the "lemons problem", that is, the online market may house products with inferior quality (Jin and Kato, 2006). On the other hand, prevailing online consumer-review mechanisms and the larger market size may attract higher-quality products to the online market (Cabral and Hortacsu, 2010; Melnik and Alm, 2002). In this paper we explicitly model these two contrasting forces and study their impact on the firm's market choice.

We conduct the study in three steps. First, we develop a benchmark model, where a firm chooses between an online market and a physical market. The product's quality is observable to consumers only if it is sold in the physical market. We show that the firm's choice is characterized by a cutoff quality level above which it chooses the physical market and below which it sells online. The benchmark model is flexible and can be extended to incorporate more features of the markets. We then extend the model to allow for an online consumer review system and a larger online market. We show that both features lead to a higher cut-off quality than that of the benchmark model. That is, they attract higher quality into the online market.

Based on the first two steps, we develop the full model, where the marginal production cost depends on product quality. We show that to choose the marketplace the firm weighs the online benefit, which is the benefit from choosing the online market over the physical market, and the online cost, which is the relative cost to switch from the physical

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¹ See Lieber and Syverson (2011) for a comprehensive review of the literature on online vs. offline competition.

market to online. The online benefit consists of three parts. First, the firm can benefit from pooling lower qualities with higher qualities and selling them at a price higher than it could command otherwise. Second, the firm pays a lower fixed cost to sell online than it would have if it were using the physical market. Third, the firm can serve a larger market when it goes online, and this is more attractive to higher qualities than to lower ones because the consumer reviews allow them to price higher once the qualities are revealed.

In the full model, we study the firm's choice in two situations, first with the marginal production cost being strictly convex in quality, and second with the cost being strictly concave. The convex case can be justified by the law of diminishing returns, but as Shaked and Sutton (1987) point out, the marginal cost may also be concave "in those industries in which the main burden of product improvement falls on fixed cost, rather than variable costs". For example, for digital electronic devices, such as sport activity tracker, digital camera, and unmanned aerial vehicles (home-use drone), it has been common to use electronic-circuit-simulation software to virtually simulate, analyze, and test new products on computer before they are actually produced. Simulation before production has proved to greatly improve design efficiency. As a result, a good design can lead to not only a better quality, but also a more efficient way to produce. Therefore, while the marginal cost is strictly increasing in quality, it is reasonable that the increment of the marginal cost is decreasing.

We show that if the marginal cost is convex in quality, then the main results in the previous two steps carry through. However, if the marginal cost is concave in quality, then there are situations where high-end qualities pool with low-end ones in the online market, leaving the physical market to intermediate qualities. The firm purveying low-end qualities chooses the online market for reasons different from those of the purveyor of high-end qualities. The firm purveying low qualities is driven by the incentive to pool them with higher qualities and to save the fixed cost. However, for high qualities, as the rate of increase of the online cost drops, the online benefit that stems from the larger consumer base and consumer reviews keeps increasing and finally outweighs the online cost, thus driving high-end qualities to also choose the online market.

Our results have two layers of policy and practical implications: First, as we discuss in more detail in the model, the pooling result under the assumption of concave-in-quality marginal cost provides a caveat for empirically evaluating the effectiveness of online consumer-review mechanisms. Secondly, to help consumers verify product quality, online markets have implemented various policies, including not only consumer reviews, but also warranty, third-party certification, and third-party dispute resolution programs. Among them, the consumer-review mechanism is arguably least costly, and also allows consumers to gain information about product quality *prior to* purchase. In this paper we show that consumer reviews can alleviate, but do not eliminate, the "lemons problem": In each set-up that we consider, low-quality products will choose the online market. This suggests that, to deal with adverse selection in the online market, more costly policies will be indispensable.

This paper is related to three streams of literature. First, there is a stream of theoretical literature on the link between online and offline businesses, especially those on the impact of consumer demand, including Dinlersoz and Pereira (2007), Koças and Bohlmann (2008), and Loginova (2009).² While these studies take into account that consumers buying online cannot inspect products before purchase, they place

² Dinlersoz and Pereira (2007) study physical retailers' adoption of e-commerce in a technology-adoption-race framework where some customers have loyalty for particular firms while others buy from the lowest-price firm. Using another model with loyal consumers versus price-sensitive "switchers", Koças and Bohlmann (2008) study price dispersion between firms with homogeneous products. Loginova (2009) studies the strategic interactions between online and offline markets in a Salop (circular city) model.

firms' marketplaces exogenous to product quality.³ By contrast we endogenize the firm's market choice with respect to product quality. The analytical framework that we use is simple and flexible, allowing us to examine the features of the marketplaces in sequence. The theme is thus closer to that of Jin and Kato (2007). Whereas they develop a model for a specific case study on sports cards, we aim at a more general framework that is flexible enough to be applied to a wider range of products. In particular, we use consumer reviews as the revelation mechanism, while Jin and Kato (2007) consider an industry-specific third-party certification system. Moreover, our finding in the full model may contrast with their results, which predict that online goods have lower quality than those sold in the physical market.⁴

We have adopted the analytical framework from the literature of voluntary information disclosure (see Milgrom, 2008), which shows that when disclosure is costly, only sellers with product quality above a threshold will disclose it (Grossman and Hart, 1980; Jovanovic, 1982). While the literature is focused on a single market, in this paper we show that with multiple marketplaces, the market choice per se can be used to (costly) disclose or hide product quality. While the result from our benchmark model is akin to the standard result, the change from a single market to multiple markets allows us to arrive at a contrasting result, where the highest qualities may pool with the lowest ones in the online market.

Thirdly, the paper is related to the literature on vertical product differentiation and its associated costs. In one of their seminal papers on vertical differentiation, Shaked and Sutton (1987) make the assumption that marginal production cost is concave in quality. Berry and Waldfogel (2010) provide empirical support for this hypothesis. The assumption is central in our set-up that leads to the pooling result in the online market. But this stream of literature and our paper have different foci: Shaked and Sutton (1987) is more focused on the impact of market size on firms' quality choice and their market shares, whereas our paper studies how features of online/offline markets affect a firm's choice of market place.

The rest of the paper is organized as follows. We develop the benchmark model in Section 2 before we investigate the effects of market size and consumer reviews in Section 3. We study the full model with the production cost of quality in Section 4. Section 5 is the conclusion. The appendix contains several proofs.

2. Benchmark model

2.1. Set-up

A firm produces a product, of which the quality q is a realization from a uniform distribution on $[0, \bar{q}]$. The firm observes the product's quality, and then chooses between two markets in which to sell the product: an online market and a physical market. Meantime the firm announces a price p .⁵ We assume that the fixed cost of selling in the physical market, including rent and utility expenses, is larger than the fixed cost of selling online. For simplicity, we assume the fixed cost for the physical market is F , and the fixed cost for the online market is zero. The marginal cost of production is constant and normalized to 0.

³ In Dinlersoz and Pereira (2007) the online good's quality differs from the offline good by an exogenous constant. In Loginova (2009) firms' choice of market type is also exogenous to the product quality, which is identical across firms. Consumers' uncertainty about an online product's quality is modeled via her uncertainty about her own type, which determines how well the product fits her and before purchase can only be found out by visiting a physical store.

⁴ Jin and Kato (2007) suggest that "[sport] cards sold in the online graded segment must have quality no worse than those sold in the retail ungraded segment, and card quality sold in these two segments must be no worse than those sold online as ungraded".

⁵ We restrict the model to a standard take-it-or-leave-it pricing scheme. We leave more sophisticated pricing schemes and transaction mechanisms, such as online auctions (Shiu and Sun, 2014), for future studies.

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