Oligopolistic price competition and adverse price effect in online retailing markets

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ABSTRACT

The majority of theoretical vertical differentiation models in the literature derive equilibrium prices that exhibit what we call an "adverse price effect:" for a low quality firm, the equilibrium price may decrease when the product quality increases. This seemingly counterintuitive theoretical result has received little attention in the literature. In order to check whether this result is simply an artifact of model assumptions (such as a duopoly under absence of differentiation costs), we present an oligopoly model with a general cost structure, and derive closed-form solutions for two special cases. Our model shows that the adverse price effect continues to hold in a more general setting and we derive conditions under which such an adverse price effect occurs. We then attempt to find empirical evidence of this phenomenon using data from the online retailing (e-tailing) industry where e-tailers selling identical products mainly differentiate with their service offerings. Our analytical and empirical results offer guidelines to e-tailers on how to price their products and decide their service offerings. The results may also have implications for firms in other industries that are characterized by vertical differentiation.

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1. Introduction

The last three decades have seen a proliferation of research in the area of vertical differentiation. Starting with the seminal paper of Gabszewicz and Thisse [8], vertical differentiation models have been developed and applied in many different situations. The theoretical models all share the following common features: the industry is characterized by duopolistic competition and firms can differentiate their product in terms of one or more "vertical dimensions." A vertical dimension is an attribute for which every consumer prefers to have more rather than less of it, a common example being "product quality." As the consumer derives a positive utility from an increased presence of the attribute, she is also willing to pay more for it. The majority of the models derive equilibrium prices that exhibit a feature which has received very little

attention: when the lower quality firm *increases* its product quality, it may have to *lower* its price. When this happens, we say that an *adverse price effect* occurs. Hence, when the firm incurs an additional cost for improving the quality, the final profit margin will get squeezed hard. Such phenomenon runs counter to popular belief that a better product will improve the profit margin because one can charge a higher price.

A close examination of the model setups in the existing literature reveals that some of the simplifying assumptions of the models may explain why the adverse price effect is always present in those models. For example, in Tirole [22, p. 296], the differentiation cost is assumed to be zero. Relaxing the most common assumptions of the existing models, we present a general vertical differentiation model. Consistent with early findings, we find that prices depend on the competitive intensity (i.e., quality differentiation) between firms. However, the high and low quality firm's quality levels have different impacts on the prices, even though they may cause the same amount of change in the quality differentiation. Under certain conditions, an increase in the quality for the low quality firm can result in a decrease in its price. Our

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model also predicts that in certain situations, prices will go up when the low quality firm improves its quality, confirming what one would normally expect. The richness of the results of our model seems to better correspond to what one observes in practice for vertically differentiated products.

This paper seeks to systematically derive conditions under which the adverse price effect occurs. We extend the analysis of the adverse price effect from two perspectives. First, we investigate whether there is a theoretical basis for the adverse price effect in a competitive situation that is less restrictive than the models in the literature. More specifically, we extend the model of duopoly that is mainly used in the literature to an oligopoly, and rather than ignoring costs of differentiation (or assuming a very simple form of the cost function), we incorporate a general cost function in our model. In this setting we derive conditions for the existence of the adverse price effect and show in which situations one is likely to encounter this effect. For the duopoly and triopoly cases, explicit conditions are obtained, whereas in the general oligopoly case, we derive an implicit condition for the existence of the adverse price effect.

Second, we empirically test whether there is evidence of such an adverse price effect. Specifically, we test for the existence of the effect in the online retailing (e-tailing) industry, which is clearly an oligopolistic setting. In addition, retailers (e-tailers) in the e-tailing industry mainly differentiate along the dimension of service quality [10,18,26]. This service differentiation is believed to affect a consumer's purchase decision and lead to willingness to pay a price premium [17].

The main contribution of this research is two folds. First, from the theoretical perspective, by presenting a general model, we explicitly identify the conditions under which the adverse price effect will occur. The conditions identified in this general setting makes the research model more relevant for practice. The second contribution is that the research empirically confirms that the adverse price effect indeed exists in the e-tailing industry. Although online retailing has been around for a decade, the competitive landscape is continuously changing, suggesting that the industry has not reached a long term equilibrium. Therefore, e-tailers need to position themselves accordingly. The conditions we identify help e-tailers better understand the competitive situation they are in, which can guide them to tailor their strategies. The combination of our theoretical results and the empirical evidence could help firms decide whether or not improving their product quality will be profitable by evaluating whether the conditions for an adverse price effect are satisfied.

The rest of the paper is organized as follows. After reviewing the literature on (mainly vertical) product differentiation in Section 2, we present an oligopolistic model with a general cost structure and discuss the conditions of the adverse price effects in Section 3. Section 4 discusses the implications for a special case (duopoly) and formulates a set of hypotheses that will be tested in a more general setting. Section 5 conducts empirical analyses using cross-sectional data collected from online retailers. Finally, Section 6 concludes and offers directions for future research.

2. Theoretical background

The theoretical model of competition we develop is based on the vertical differentiation model in a one-dimensional setting. Some of the classical work include Gabszewicz and Thisse [8] and Shaked and Sutton [20], who show that competing firms will choose to locate at the extreme ends of the quality spectrum to reduce price competition. Moorthy [13] extends the basic model by incorporating a quadratic differentiation cost and demonstrates that in equilibrium firms choose products that are differentiated.

Many researchers (for example, [7,14,5,23,25]) have subsequently studied this game under different settings. In the Economides [7] and Neven and Thisse [14] models of two-dimensional differentiation, firms first choose product (consisting of two characteristics with one horizontal dimension and one vertical) and subsequently choose price. Both models show that differentiation will still only occur in one dimension; however, under different conditions, it can occur in the horizontal or vertical dimension. Horizontal-vertical differentiation models have also been used to analyze retail channels. Coughlan and Soberman [4] use such a model to analyze under which conditions a manufacturer should establish outlet stores, where the vertical dimension measures the service a consumer enjoys from the retailer and the horizontal dimension represents location.

Besides establishing long-term differentiation strategies along non-price dimensions, the above product differentiation models also imply the adverse price effect: in the short term, prices may drop if the low quality firm increases its quality level. More formally, we say that an adverse price effect occurs whenever $\frac{\partial p_i^*}{\partial s_i} < 0$, where p_i^* is the equilibrium price and s_i the quality level of a firm i. For example, in models with zero differentiation cost and a covered market (such as [22,2]), the adverse price effect seems always present. In models with zero differentiation cost but where the market is not covered (such as [5,25]), the adverse price effect exists for the low quality firm when the quality differentiation between the two firms is small. In Moorthy's model with a quadratic cost structure, the adverse price effect is present when both the differentiation cost and the quality differentiation between the two firms are small. In the model by Vandenbosch and Weinberg [23], price always decreases with the increased quality under both the asymmetric and the dominated characteristics competition. Table 1 summarizes some of the representative differentiation models as well as the model assumptions. Except for Bresnahan [3], all models listed in Table 1 study a duopoly setting without empirical tests. Bresnahan [3] studied a general oligopoly model with non-zero differentiation costs, but failed to derive explicit expressions for the equilibrium prices. In the empirical part,

Table 1
Vertical differentiation models with adverse price effects

Source	Differentiation dimensions	Competing firms	Differentiation costs	Covered market
[3]	1	≥2	general	No
[5]	1	2	zero	No
[8]	1	2	zero	No
[2]	≥2	2	zero	Yes
[13]	1	2	quadratic	No
[20]	1	2	zero	No
[22]	1	2	constant	Yes
[23]	2	2	zero	Yes
[25]	1	2	zero	No