



NORTH-HOLLAND

A Model of Endogenous Quality Management

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This paper is concerned with product quality, defined as a kind of durability. Existing models of product quality (in the sense considered here) depend on the idea of signaling, itself driven by an informational asymmetry dictated by “Nature.” The paper proposes an alternative approach, which endogenizes the quality management process. A model is developed that is applicable to the markets for consumer durables and for some intermediate goods. Both competitive and monopolistic markets are considered, and some comparative static results are obtained. © 2000 Elsevier Science Inc.

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I. Introduction

In the management literature, “product quality” is defined extremely broadly. The term has been used to refer to safety, availability, maintainability, reliability, usability, and even price (see, e.g., Besterfield, 1986). Generally speaking, quality is best thought of as a characteristic of the product with the property that all consumers prefer more of it to less, at a given price. Some such characteristics will be known to the consumer before purchase, while others will not. For personal computers, for example, the former type of characteristic might include the size of the processor chip (486, Pentium, Pentium II, Pentium III, etc.) or its speed (300 Mhz, 450 Mhz, 500 Mhz, etc.), while the latter type might include product lifetime, repair costs, etc. Most goods have characteristics of both types, though the second notion of quality raises more interesting questions for firms, consumers, regulators, and for economic theory. It is the notion of quality dealt with in this paper.

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Firms devote considerable resources to influencing the quality of their products. This influence operates at the level of product design, production process, and post-production quality control. The unity of the quality management process is often stressed in the management literature. The distinction between production and quality control decisions is frequently blurred. For example, a firm may seek to raise its production quality by, in effect, demanding tighter quality control from its components suppliers. Thus a production decision in one firm is inseparable from a post-production quality control decision in another. The model developed in this paper incorporates production, quality control, warranty and pricing decisions into the firm's overall (expected) profit maximizing behaviour. Product design decisions are not considered.

In the model presented here, both firms and consumers will be assumed to be ignorant at the moment of purchase, as to the quality of any given product, though they will be assumed to know the probability distribution of quality. Thus, the model is one of imperfect but symmetric information. It will further be assumed that the firm, though just as ignorant as consumers, is less risk-averse. There thus arises a demand, on the part of consumers, for insurance. This might, for example, be provided in the form of a product warranty offered by the firm, or an insurance policy provided jointly with the product. In the case of intermediate goods, "consumers" may be thought of as firms and "warranties" as compensation clauses built into standard supply contracts. Heal (1977) develops a model, involving warranties, which adopts precisely these informational assumptions. He remarks:

"Typically the quality control is sufficiently imperfect that no one [i.e., neither seller nor buyer] will know in advance of [a product's] use what [its] quality will be, and consequently some form of guarantee will be offered." [Remarks in brackets added.]

In Heal's model, the firm is assumed to produce a probability distribution of qualities which is simply taken as given. He does not seek to model the process by which the firm attempts to alter that distribution. In this paper this process is modeled. In particular, the firm is able to influence the distribution of quality in its marketed output, both by production (choice of technique) decisions and by quality control decisions. It will also be able to offer a product warranty to the market. A standard problem, often assumed away, in the literature on quality, is that of moral hazard on the part of consumers. If consumers can themselves influence the probability or size of a claim under the warranty, for example by failing to take proper care of the good during consumption, then the economic role of warranties may be reduced. See, for example McKean (1970), Oi (1973), and Priest (1981). For simplicity, moral hazard will be assumed away in this paper. Warranties, whether voluntary or legally compelled, have an important bearing on quality management decisions because the higher the quality of a firm's marketed output, the lower the likely warranty costs experienced by the firm. Thus, warranties provide the firm with an incentive to market high-quality products. This connection between warranties and quality management has been apparent to managers for some time. Wright (1980), for example, describes events at General Motors:

"I instituted a programme for testing and repairing faulty cars as they came off the assembly line—and the results were phenomenal. It cost about \$8 a car, which drove The Fourteenth Floor up the wall. But I figured one way or the other we would end up fixing the defects or paying to have them fixed through recall campaigns or dealer warranty bills . . . The internal quality control audit revealed a 66% improvement in the quality of

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