PRICE REACTION FUNCTIONS AND CONJECTURAL VARIATIONS
An Application to the Breakfast Cereal Industry
by
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ABSTRACT
Price conjectural variations are estimated to measure the degree of price competition in a product differentiated oligopoly. The empirical model is a simultaneous equation system of product demand and price reaction functions. Own and cross price demand elasticities are estimated in conjunction with the price conjectural variations and price reaction function elasticities. The conjectural variations are estimated for pairs of ready-to-eat breakfast cereal products using brand price and quantity data. The empirical results reject competitive brand pricing behavior in favor of independent or collusive pricing. Further, the hypothesis of a unique consistent conjecture is rejected.

1. Introduction
Conjectural variations often are used to characterize the degree of competition in oligopoly markets. Simply stated, the conjectural variation is defined as a firm's anticipated response from a rival firm if the firm changes its price or output. For example, in a duopoly market with homogeneous products, if a firm were to reduce its quantity and anticipates that the rival firm will also reduce its quantity equally, then the conjectural variation is one and leads to the monopoly outcome. On the other hand, if a firm were to reduce its quantity and anticipates that the rival firm will increase its quantity in response, then the conjectural variation is negative one and leads to a competitive outcome. A conjectural variation of zero, meaning the firm does not anticipate any response by the rival firm, leads to the familiar Cournot outcome. Because of this broad range of possible theoretical outcomes, recent work has focused on directly estimating conjectural variations to assess competition in particular industries.

The majority of empirical conjectural variation studies has been limited to homogeneous product industries with a uniform

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industry price. The extension of the oligopoly model to a product differentiated market requires that firm specific demand conditions be taken into account. This paper extends recent efforts to estimate market power in a product differentiated market in two ways. First, firm price conjectural variations are estimated in a price reaction function which defines the firm's price based on the rival firm's price. In this way, both anticipated and actual price responses are estimated. Second, own and cross price demand elasticities are estimated along with the price conjectural variation. In differentiated product markets, the gains from colluding with a rival firm will depend upon the firm's demand elasticity.

This framework allows for statistical tests of various types of oligopolistic behavior to be performed. Specifically, the estimated price conjectural variations can be tested against the conjectural variations derived under alternative hypotheses of rivalrous, independent, and collusive behavior. In addition, the hypothesis that the conjectural variations are "consistent," with its attendant unique equilibrium, can be tested.

The empirical model is tested by examining price competition between pairs of ready-to-eat breakfast cereal products. Individual brand data were collected during the course of the antitrust case brought by the Federal Trade Commission in the 1970s against Kellogg, General Mills, and General Foods. Because the firms produce a large number of differentiated breakfast cereal products, price competition is estimated for competing brand pairs rather than for the competing firms.

Overall, the empirical results suggest that cereal prices are noncompetitively high. Generally, the hypothesis of rivalrous brand pricing is rejected, but the hypotheses of independent or collusive pricing cannot be rejected. In addition, the degree of price competition between brands appears to depend primarily on whether the estimated demand elasticities show that the brand has a close demand substitute. Finally, the hypothesis of a unique consistent conjectures equilibrium is rejected.

A description of the breakfast cereal industry and a model of price reaction functions are presented in sections 2 and 3. Demand and price reaction function estimates, followed by price conjectural variation estimates and hypothesis tests are presented in sections 4 and 5. The paper ends with a summary and conclusion section.

2. Ready-to-Eat Breakfast Cereal Industry

The price reaction function model is applied to pairs of breakfast cereal products from the U.S. ready-to-eat breakfast cereal industry. The breakfast cereal industry can be characterized as a