

# The impact of collusion on price behavior: Empirical results from two recent cases

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## Abstract

We use extended ARCH and GARCH models to examine the differences in the behavior of the first two moments of the price distribution during collusive and competitive phases of two recently discovered conspiracies, citric acid and lysine. According to our results, the conspirators managed to raise prices by 9 and 25 cents per pound in the short-run relative to non-collusive periods. Also, the variance of prices during the lysine conspiracy was lower and the variance of prices during the citric acid conspiracy was higher than during more competitive periods. The proposed methodology may be used for antitrust screening and prosecution purposes.

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## 1. Introduction

Studies of cartels effectiveness have primarily focused on changes in price levels during the collusive periods (Levenstein and Suslow, 2006). In part, this focus may be explained by the near absence, until recently, of rigorous game-theoretic models that predict changes in other characteristics of price distribution due to collusive behavior. An empirical method that consistently measures changes in price variation from

cartel conduct might be used by antitrust authorities to screen alleged illegal firm conduct. In addition, it might be useful as an additional technique to prove the fact of injury in antitrust legal proceedings concerning price-fixing conspiracies.

We use empirical analysis to examine the impact of collusion on the behavior of the first two moments of the price distribution (mean and variance). Following theoretical predictions and empirical findings reviewed below, we hypothesize that the behavior of the first two moments of the price distribution under collusion is different than during non-collusive periods. In particular, we expect that the mean price is higher and the variance of the price is lower during collusion relative to non-collusive periods. The presence of one of the

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conditions (e.g., only price increase or variance decrease) might also indicate the presence of collusive conduct in the market. Alternatively, a failure to find support for both hypothesized changes is likely to indicate the absence of collusion on a given market.

Our study has at least two distinct features. First, we use price data from two international cartels prosecuted in the late 1990s, the citric acid and lysine. Previous empirical studies have examined domestic conspiracies and relied either on the data characterizing a bid-rigging conspiracy (Abrantes-Metz et al., 2006) or the data from markets affected by a hypothesized tacit collusion (Brannon, 2003; Abrantes-Metz et al., 2006). Both the citric acid and lysine markets were affected by overt collusion. These conspiracies were organized in the markets with a different type of market institution than those considered in the previous empirical studies. Second, we employ extensions of the traditional autoregressive conditional heteroscedasticity (ARCH) and generalized ARCH (GARCH) models. There are two advantages to using the ARCH and GARCH models. The first advantage is that these econometric procedures model the impact of collusion on the price mean and variance behavior simultaneously. Thus, we can use a parsimonious model to test whether a conspiracy has a statistically significant impact on the behavior of the first two moments of the price distribution with and without collusive conduct. The second advantage is that we may expect the mean and variance to change over time for other reasons, and these models can represent such changes in the price mean and variance for a cartelized product before, during and after a hypothesized or known conspiracy. The models do not require the presence of cost data but can be extended as cost information or other data characterizing the conspiracy become available. The proposed econometric procedure may be used by antitrust authorities to screen firm conduct. In addition, it may be used as an alternative to the econometric models commonly employed in court proceedings to quantify the effect of conspiracy on market price and to assess damages.

The paper is organized as follows. A review of the related theoretical, empirical, and experimental economics literature is presented in Section 2. A short description of the citric acid and lysine markets and conspiracies follows in Section 3. The data and the empirical models are discussed in Sections 4 and 5, respectively. The estimation results are presented in Section 6, and are followed by the discussion of the screen for collusion in Section 7. Finally, the conclusion of our study is presented.

## 2. Review of theoretical, empirical and experimental findings

The behavior of the first two moments of the price distribution (mean and variance) in markets with different structures has been extensively analyzed in the theoretical literature<sup>1</sup>. In general the theoretical literature supports the statement that, *ceteris paribus*, as a market moves from competition to oligopolistic or monopolistic structures, price variability tends to decrease (Stigler, 1961, 1964; Salop, 1977; Reinganum, 1979; Pratt et al., 1979; Salop and Stiglitz, 1982; Carlson and McAfee, 1983; Dana, 1999). A number of empirical studies find support for the equilibrium conditions derived in the theoretical literature (Pratt et al., 1979; Dahlby and West, 1986; Borenstein and Rose, 1994). These studies provide important insight on the price mean and variance behavior in markets with different structures. Our study analyzes price behavior in overtly cartelized markets. Therefore, we focus on the discussion of the studies that analyze price behavior in and out of collusion.

Under modern antitrust standards, intent to restrict output and/or to control market price is considered to be illegal action. Expectations of cartel participants about the probabilities of being detected, caught, and sanctioned as well as the expected size of sanctions to be paid impact their decisions on pricing strategies during collusion<sup>2</sup>. Consequently, a cartel pricing strategy is different from a pricing strategy of an oligopolist in the market free from cartelization. Following cartel agreements, cartel participants get control over the price movement. The price movement under collusive actions should be adequately linked to fundamentals to avoid attracting the attention of buyers and government authorities and to avoid detection. Some of these features are incorporated in the models developed by Harrington (2004a, 2004b, 2005b).

Harrington (2004a, 2005b) uses a dynamic approach to develop theoretical models that examine cartel pricing in the presence of antitrust authorities. In Harrington (2005b) the basic model is a dynamic profit-maximization problem of a typical cartel participant. The objective is to choose a price path that maximizes the present value of a cartel participant's income flow.

<sup>1</sup> Surveys and discussions of the theoretical and empirical literature on collusion and price dispersion are presented in Connor (2005a) and Harrington (2005a).

<sup>2</sup> In addition, some of these factors impact cartels' pricing strategies after collusion as well. In particular, colluding firms may exercise tacit collusion during the post-cartel period.

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