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Assessing new empirical industrial organization (NEIO) methods: The cases of five industries

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Abstract

The methods proposed in the new empirical industrial organization (NEIO) literature have made significant contributions to our understanding of competitive behavior. However, these methods have yet to be compared with each other for their performance in explaining and diagnosing competitive market conduct. This inter-method comparison is important because conclusions about competitive behavior based on these methods have significant strategic as well as policy implications for firms. Our objective in this paper is to examine the performance of these different NEIO methods in terms of their discriminatory power, ability to identify strategic variables, and robustness in estimation. For empirical demonstration, we use data from diverse industries such as microprocessors, personal computers, facial tissue, disposable diapers and automobiles. Our results suggest that two commonly used NEIO methods-conjectural variation and non-nested model comparison-exhibit quite good convergence with each other and are consistent with a traditional time series method. This suggests that simpler methods such as conjectural variations deserve more credit. We also find that using these methods in tandem provides valuable additional information that may not be available when using any one method alone. While the emphasis in this study is on comparing different methods of analyzing competitive interaction, the findings also reveal some substantive insights about each market studied.

Keywords: Competition; Empirical game theory; Industrial organization

1. Introduction

There has been an increase in empirical research in both economics and business analysis that studies competitive conduct using what is often referred to as the new empirical industrial organization (NEIO) paradigm. A review of the NEIO and related methods is provided in Bresnahan (1989) and more recently in Kadiyali, Sudhir, and Rao (2001). Many of these NEIO studies have used the conjectural variations (CV) approach to infer competitive conduct, which assumes that each firm believes that its choice of price (or some other strategic variable) will affect the price selected by its rival, and that the rival's reaction can be captured by a single parameter (Iwata, 1974). While a 'single coefficient' approach has obvious appeal, it is not without its weaknesses. Corts (1999) and Kim and Knittel (2004) illustrate that there can be severe biases in estimates of mark-up levels in marginal cost models using the conjectural variations (conduct parameters) framework. Interpretation of parameters poses another problem. For example, the CV method assumes that a positive CV parameter (price raises met with price increases) indicates cooperation. But a positive CV also implies that price decreases are met with price decreases. Therefore, it is not clear if meeting a price decrease with a price decrease of similar magnitude implies cooperation or a non-cooperative tit-for-tat strategy.

The main alternative to the CV method is the *Menu Approach*, also referred to as the Non-Nested Model Comparisons (NNMC) approach. This method requires the alternative competitive models to be developed and the solutions obtained under different assumptions about competing firms' behavior such as Nash, Stackelberg, etc. Assuming that the observed market data reflect the equilibrium corresponding to a particular mode of conduct (e.g., Nash or Stackelberg), the mode of conduct that provides best fit to the data is considered the most accurate description of the competitive structure of the market.

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The purpose of this study is to compare the performance of these two popular NEIO methods in terms of their discriminatory power among different competitive modes, ability to identify strategic variables (price or quantity), as well as robustness to time aggregation and the sample size. We do this comparison by applying the two methods to data from five different markets (microprocessors, personal computers, facial tissue, disposable diapers and automobiles) and compare the results for each market. We also compare the results from the CV and NNMC methods with those obtained by the Granger Causality (GC) test using the same performance criteria. A time-series based approach, the GC test has been widely used to study competitive interactions (Hanssens, 1980), and a comparison of the CV and NNMC methods with the GC test allows us to examine the extra value-added of the NEIO methods over traditional methods.

More specifically, in each of the five markets, we apply the three methods aforementioned – CV, NNMC, and GC – and attempt to infer the following:

(1) *Nash vs. Stackelberg vs. collusion*: The first key question we explore is whether the prevailing mode of competition in a market is best described as independent Nash, Stackelberg leader–follower, or Collusion.
(2) *Choice of strategic variable (prices vs. quantities)*: Studies published in the previous literature consider one or more of the marketing mix instruments (price, advertising, promotions, etc.) as possible strategic variables (Besanko, Gupta, & Jain, 1998; Kadiyali, Vilcassim, & Chintagunta, 1998), and attempt to uncover which of these is the likely strategic variable in the industry. In all these models, quantity is assumed to be an outcome, and not a decision variable. In contrast, theoretical economists have been quite concerned about whether the strategic variable is price or quantity, because implications from each are often quite different if we consider quantity competition vis-à-vis price competition (e.g., Vives, 1984). It is well established that prices are usually strategic complements (Bulow, Geanakoplos, & Klemperer, 1985) and price reaction functions are positively sloped. On the other hand, production quantities (e.g., capacities) are strategic substitutes and quantity reaction functions typically have negative slopes.

In the next section, we describe the data from five different markets used in our study. In Section 3, we discuss how we apply the three methods to the five data sets. We discuss the results in Section 4. In Section 5, we examine the degree to which the various methods provide converging conclusions and also the unique insights obtained from one approach that are not available from the others. The identification of competitive mode together with identification of the key strategic variable provides useful information on the nature of competition within each market. We conclude with a discussion of the limitations of this study and some thoughts for future research.

2. Data

We examine data from five different markets. These are from the microprocessor, personal computer, facial tissue, disposable diaper and automobile categories. The five data sets offer great variation in number of observations, time aggregation, number of variables, and industry type. The common features of all these data sets are that in each of the markets being studied, there are two dominant players (e.g., Intel and Motorola in microprocessors). This allows us to focus on only two competitors in each market. The summary statistics for all five data sets are provided in Table 1.

Table 1
Data statistics of five product markets

Microprocessor brands	Intel		Motorola	
Statistics	Price ($)	Sales (000 Units)	Price ($)	Sales (000 Units)
No. of observations	36 quarters	36 quarters	36 quarters	36 quarters
Mean	139.9	1170	79.2	337
Standard deviation	100.7	1238	51.7	279
Correlation between two brands	Price correlation = 0.967 [a] (p<0.01); Sales correlation = 0.641 [a] (p<0.01)			
Personal computer brands	**Compaq**		**Dell**	
Statistics	Price ($)	Sales (Units)	Price ($)	Sales (Units)
No. of observations	11 quarters	11 quarters	11 quarters	11 quarters
Mean	1943.3	556,528	2180.3	241,159
Standard deviation	343.4	163,001	488.3	115,855
Correlation between two brands	Price correlation = 0.943 [a] (p<0.01); Sales correlation = 0.794 [a] (p<0.01)			
Facial tissue brands	**Kleenex**		**Puffs**	
Statistics	Price ($)	Sales (Units)	Price ($)	Sales (Units)
No. of observations	242 weeks	242 weeks	242 weeks	242 weeks
Mean	1.40	542,578	1.23	676,001
Standard deviation	0.14	319,662	0.15	240,138
Correlation between two brands	Price correlation = 0.047; Sales correlation = 0.174 [b] (p<0.05)			
Disposable diaper brands	**Huggies**		**Pampers**	
Statistics	Price ($)	Sales (Units)	Price ($)	Sales (Units)
No. of observations	110 weeks	110 weeks	110 weeks	110 weeks
Mean	12.10	203,136	8.20	15,729
Standard deviation	1.10	48,303	4.24	12,561
Correlation between two brands	Price correlation = 0.082; Sales correlation = −0.016			
Automobile brands	**Ford Thunderbird**		**Chrysler New Yorker**	
Statistics	Price ($)	Sales (Units)	Price ($)	Sales (Units)
No. of observations	27 years	27 years	27 years	27 years
Mean	6409.8	104,583	6037.2	36,994
Standard deviation	1035.7	33,102	1585.4	6,821
Correlation between two brands	Price correlation = 0.271 [b] (p<0.05); Sales correlation = −0.139			

[a] Significantly different from zero (p<0.01).
[b] Significantly different from zero (p<0.05).