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# Oil production responses to price changes: an empirical application of the competitive model to OPEC and non-OPEC countries

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## Abstract

Falling oil prices over the last decade, accompanied by over-production by some OPEC members and the growth of non-OPEC supply, warrant further empirical investigation of the competitive model to ascertain production behavior. A supply function, based on a modification of Griffin's model, is estimated using data from 1973–1997. The sample period, unlike Griffin's, however, includes phases of price increase (1970s) and price decrease (1980s–1990s), thus providing a better framework for examining production behavior using the competitive model. The OPEC results do not support the competitive hypothesis; instead, a negative and significant price elasticity of supply is obtained. This result offers partial support for the target revenue theory. For most of the non-OPEC members, the estimates support the competitive model. OPEC's loss of market share and the drop in the share of oil-based energy should signal adjustments in price and quantity based on a competitive world market for crude oil. © 2002 Elsevier Science B.V. All rights reserved.

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## 1. Introduction

The soaring prices of crude oil brought about by OPEC's actions during the 1970s were associated with the recession in many oil-importing countries. The economic consequences, including rapid inflation, trade deficits, external debt and

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budget deficits, were the focus of many studies, for example Fried and Schultze (1975) and Marquez (1986). In response to the crisis, many countries highly prioritized strategies for the development of alternative sources of energy and the possibility of inter-fuel substitution in their economic development plans. Griffin and Gregory (1976), Pindyck (1979) and Apostolakis (1990) have analyzed some of the implications of these strategies. After the first oil shock (1973–1974), OPEC was widely regarded as a potential force in the world oil market with vitality, stability and longevity. That conclusion or perception triggered a plethora of studies aimed at explaining pricing and production behavior; some of these include Blitzer et al. (1975), Fischer et al. (1975), Kalymon (1975), Cremer and Weitzman (1976), Hnyilicza and Pindyck (1976), Danielsen (1980), Newbery (1981), Verleger (1982), Griffin (1985) and Gately (1995). The methodologies employed in these studies include: (a) the theory of exhaustible resources; (b) game theory; (c) simulation; (d) industrial economics; and (e) economic efficiency hypothesis. Mabro (1992) critically evaluated some of these approaches. An important aspect of OPEC's production behavior is the propensity for some members to cheat on quotas; Griffin and Xiong (1997) examined this issue.

MacAvoy (1982) added considerable credibility to the view that oil prices can be best explained by a model focusing on demand or supply (market fundamentals) rather than cartel behavior. Griffin (1985) examined four different production models for OPEC members using data for the period 1971–1983; these models are: (a) competitive model; (b) cartel model; (c) target revenue model; and (d) property rights model. Jones (1990) updated Griffin's cartel and competitive models using data from 1983:IV to 1988:IV. The limitation of Griffin's study is that the time period covered is one of only rising prices. Structural changes in the world oil market, the rapid growth of non-OPEC supply and the rapid decline in oil prices in the last decade, accompanied by over-production by some members of OPEC to enhance revenues, warrant further research to evaluate and forecast production behavior of oil exporters. Watkins and Streifel (1998) indicated the renewed interest in the competitive model of oil production.

This paper estimates a supply function of oil production for oil producers (OPEC and non-OPEC) using data for the period 1973–1997. The methodology is an extension of Griffin (1985), with some modifications. The main significance of this study is the use of data that include phases of both rising and falling prices; therefore, the results should provide better estimates of production under price fluctuations. Central to the analysis is the estimation and the implication of the price elasticity of supply. A positively sloped supply function or positive elasticity of supply is consistent with the competitive hypothesis. We contend that OPEC's loss of market share, because of the rapid growth of non-OPEC sources of supply, should constrain OPEC's production to market forces; as such, a positive elasticity of supply is hypothesized. In addition, other production-related implications could be derived from the results; for example, a negative supply elasticity partially supports the target revenue theory (TRT), developed by Ezzati (1976), Cremer and Isfahami (1980) and Teece (1982), and empirically estimated by Griffin (1985). Based on OPEC's production behavior in the mid-1970s, the TRT postulates that

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