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The effect of uncertainty and aggregate investments on crude oil price dynamics

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Abstract

This paper is a study of the dynamics of the oil industry and we derive a mean reverting process for the crude oil price. Oil is supplied by a market leader, OPEC, and by an aggregate that represents non-OPEC producers. The non-OPEC producers take the oil price as given. The cost of non-OPEC producers depends on past investments. Shifts in these investments are influenced by costs of structural change in the construction industry. A drop in the oil price to below a given level triggers lower investments, but if the oil price reverts back to a high level investments may not immediately expand. In an uncertain oil demand environment cost of structural change creates a value of waiting to invest. This investment behaviour influences the oil price process. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

In the long-run the oil price seems to follow a mean reverting pattern. That is, in the case of high oil prices the underlying price trend is downward and in the case of very low oil prices the trend is upward. In periods of a close to perfectly

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competitive oil market the mean reversion in prices can be explained almost solely by restricted supply flexibility in an environment of stochastic demand. In the case of an unexpected jump in oil demand it takes time to increase production. Hence, the price of oil increases until new oil fields are developed and transport capacity is provided to a sufficient degree in order to revert the oil price towards a long-run average price level. In a perfectly competitive market the long-run average price level is determined by long-run marginal costs, which in the oil market is mainly determined by available oil reserves and technology.

Some of the reasons for restricted supply flexibility are irreversibility of investment, time-to-build and restricted construction capacity. The cost of reducing these restrictions may in many cases be substantial. In the oil industry this is especially the case for large-scale offshore oil field developments. High oil prices may trigger a decision to develop new oil fields, but restricted construction capacity implies that it will take time from when a project is initiated to first oil. To adjust the capacity of the construction industry is costly. To increase the capacity entails substantial investments and labour force training. To decrease capacity may cause significant regional unemployment and loss of know-how.

Since the early 1970s the oil price has been heavily influenced by the market power of the OPEC cartel. Besides internal rivalry, OPEC's main challenge has been the trade-off between price and market share. High prices have triggered development of non-OPEC oil fields that by no means would have been profitable in a perfectly competitive market. During the high oil price regime from 1979 to 1985, OPEC production was reduced by approximately 45% due to a loss of market shares and reduced demand. Because of lower oil prices after 1986, OPEC production during the late 1990s is back at the same level as before the two oil price shocks in 1973 and 1979. A reduction in the marginal cost for the non-OPEC producers due to technological progress has challenged OPEC's market power during the 1990s. Hence, despite lower oil prices than in the early 1980s there have been substantial oil field developments outside OPEC during the 1990s. The drop in oil prices in 1998 to pre-OPEC levels, despite improved oil prices during 1999, curbed investments for 2000 and 2001.

At present, OPEC produces slightly above 40% of the total world consumption of crude oil. Back in the mid-1980s the OPEC market share was only marginally above 30%, which was down from above 50% in the first part of the 1970s. The market share of OPEC is in strong contrast to OPEC's share of known oil reserves. OPEC's share of known oil reserves is approximately 77% and the Middle East OPEC countries have alone 65% of known reserves. The production cost of OPEC and in particular, that of the Middle East countries is significantly below that of the rest of the world. According to rough estimates (The Economist, 1999) production cost of oil, including costs related field development, is approximately US\$2 per barrel in the Middle-East in contrast to US\$10 in the US-Gulf and US\$11 in the North Sea. Hence, OPEC operates as a leader in the crude oil market and restricts production to a significant degree in order to keep prices at a preferred level from an OPEC perspective.

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