Available online at www.sciencedirect.com
ScienceDirect
Energy Economics 29 (2007) 18–27
Energy Economics
www.elsevier.com/locate/eneco

Are there exploitable inefficiencies in the futures market for oil?

William E. Shambora *, Rosemary Rossiter

335 Bentley Annex, Ohio University, Athens, OH 45701, Unites Sates

Received 16 December 2004; accepted 14 September 2005
Available online 7 November 2005

Abstract

If the crude oil futures market is not efficient in the Fama sense, profitable trading opportunities may exist. This paper uses an artificial neural network model with moving average crossover inputs to predict price in the crude oil futures market. The predictions of price are used to construct buy and sell signals for traders. Compared to those of benchmark models, cumulative returns, year-to-year returns, returns over a market cycle, and Sharpe ratios all favor the ANN model by a large factor. The significant profitability of the ANN model casts doubt on the efficiency of the oil futures market.

JEL classification: G190–General Financial Markets: Other

Keywords: Artificial neural network; Futures market; Oil prices

1. Introduction

As oil prices have climbed, the financial news has been filled with accounts of diverse types of investors from individuals and pension funds to investment banks and hedge funds joining the "black gold rush."[1] The futures market for oil is the preferred trading arena for hedgers and speculators wishing to place their bets on that market's next move. The hundreds of millions of dollars wagered by these new players in the futures market is said to have resulted in higher prices and increased volatility.

* Corresponding author. Tel.: +1 740 593 1845; fax: +1 740 593 0181.
E-mail address: shambora@ohio.edu (W.E. Shambora).
[1] See Times Newspapers Inc., Sept. 20, 2004.

0140-9883/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.eneco.2005.09.004

Futures markets are differentiated from actual asset markets by the fact that futures are a zero sum game, where for every long position there must be a short position. Every price movement in a futures market that creates a profit for one participant will result in an equal loss for another participant. With heavy participation of informed traders on both sides, futures trading should perform particularly well as a price discovery mechanism based on the known market fundamentals. Thus neoclassical economic theory suggests that futures markets should be highly efficient, with no room for excess returns. What then explains traders' enthusiasm for short-term bets on oil futures?

An explanation for the behavior of traders may be rooted in the belief that there are anomalies in asset pricing which persist, at least in the short-run. In the scholarly literature, proponents of behavioral finance have provided empirical evidence as well as theoretical explanations of price patterns inconsistent with the efficient market hypothesis, such as evidence of negative serial correlation of stock returns explained by an over-reaction of traders to changes in market fundamentals. In other words, traders in the oil futures market may believe that anomalies in pricing persist and that price movements contain predictable patterns which can be exploited for profitable returns.

Long before the contributions of behavioral finance, technical analysts have claimed the ability to generate excess returns solely on the basis of interpretations of historical price patterns.[2] Technical analysis has evolved from looking for patterns on price charts to using computer programs based on a variety of weighted and unweighted price averages, to the current state of the art which employs artificial intelligence [AI] techniques. A branch of AI technology that has been experiencing strong expansion in its application to commodity trading is the field of artificial neural networks [ANN].

If historical price patterns can indeed be used to predict future prices, the market would not fit the strict definition of efficient markets laid out by Fama (1970). If inefficiencies exist, there could be profitable trading opportunities. The purpose of this paper is to examine the possibility that the oil futures market is not an efficient market in that subtle price patterns that can be exploited for profitable trading. To explore this question we estimate an artificial neural network model for the price of nearby oil futures with technical analysis rules as inputs. We find that, without transaction costs and disregarding slippage, the ANN model can produce profitable trading signals for several years in the future, thus casting doubt on the efficiency of the oil market.

In Section 2 below, we reference selected literature as background, including studies which have used neural network models in technical analysis. Section 3 provides a general discussion of neural network modeling and describes a network with technical analysis rules as inputs. Benchmark models are given in Section 4. Empirical results are presented in Section 5, and concluding remarks in Section 6.

2. Background

The literature investigating the predictability of financial asset prices is vast and diverse. The econometrics used to test the efficient market hypothesis and important empirical results of prominent researchers can be found in Campbell et al. (1997) and the references therein. Behavioral finance, which is part of the broader study of behavioral economics, seeks to translate

[2] See, for example, "Hoyle" (1898).