Chapter XVI
Modelling and Trading the Soybean-Oil Crush Spread with Recurrent and Higher Order Networks:
A Comparative Analysis

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ABSTRACT

This chapter investigates the soybean-oil "crush" spread, that is the profit margin gained by processing soybeans into soyoil. Soybeans form a large proportion (over 1/5th) of the agricultural output of US farmers and the profit margins gained will therefore have a wide impact on the US economy in general. The chapter uses a number of techniques to forecast and trade the soybean crush spread. A traditional regression analysis is used as a benchmark against more sophisticated models such as a MultiLayer Perceptron (MLP), Recurrent Neural Networks and Higher Order Neural Networks. These are then used to trade the spread, the implementation of a number of filtering techniques as used in the literature are utilised to further refine the trading statistics of the models. The results show that the best model before transactions costs both in- and out-of-sample is the Recurrent Network generating a superior risk adjusted return to all other models investigated. However in the case of most of the models investigated the cost of trading the spread all but eliminates any profit potential.

INTRODUCTION

Motivation for this chapter is taken from Dunis *et al.* (2005) who discover that trading the Gasoline Crack spread can lead to abnormal out-of-sample returns especially when traded using the neural network architectures described here. Further it is discovered that the application of a filter can further refine the trading statistics achieved. The Soybean Crush Spread can be interpreted as the profit margin gained by processing soybeans into soybean oil and soybean meal. It is simply the monetary difference between 1 bushel of soybeans on the one side and 1 bushel's worth of soybean oil and 1 bushel's worth of soybean meal on the other, all three of which have futures contracts that are traded on the Chicago Board of Trade (CBOT). The focus of this chapter will be the spread between soybeans and soybean oil henceforth called "soybean-oil spread."

Although large scale production of soybeans occurred only after the 2nd World War soybeans are now very important to US agriculture. In 2004 around 23% of all crops (by acre) planted in the US were soybeans. Approximately 400,000 farmers harvest 3.1 billion bushels of soybeans annually. Approximately 39 million tons of soymeal and about 18,800 million pounds of soybean oil was manufactured in the US.[1] It is easy to underestimate the impact soybean prices have on the US economy, and in particular the agricultural economy.

Soybeans can be processed into two main products, soymeal and soyoil. Soymeal is used extensively in livestock feeds, mainly for poultry, swine and cattle. However livestock feed is a very substitutional good and therefore demand for soymeal is influenced by the demand for livestock and the relative prices of other protein meals (such as canola, rapeseed or cottonseed meal). The demand for soymeal can therefore have an influence on the price of soybeans.

Soyoil is the most widely consumed oil in the US, in fact it forms 75% of all oils consumed as vegetable oils and fats.[1] High vegetable oil prices in the late 1990s spurred a global expansion in the production of soyoil. An increase in crushing activity led to an oversupply of soymeal and a collapse in the price of soymeal, along with protein meals in general. Uses of soyoil are extensive for example, soybean oil can be used in paints, waterproof cements, alkyd resins, soaps, shaving creams, greases and lubricants, enamels, varnishes, leather dressing, caulking compounds, grain-dust suppressant and as an alternative fuel (biodiesel). With the increase in petroleum prices this latter use of soyoil is starting to become of particular interest.

In fact soy-biodiesel may well prove to be quite a breakthrough in sustainable energy resources. In small quantities (~2% soyoil and 98% traditional diesel fuel) biodiesel can provide both economic and lubrication benefits over straight diesel fuel. In larger quantities (~20% soyoil and 80% traditional diesel fuel) it can provide significant emissions benefits to cut air pollution. In the extreme case (~100% soyoil) it could provide a fully sustainable replacement for traditional diesel fuels.[2]

The calculation of the soybean-oil spread is not a straight forward one, since the pricing of both contracts is in different units. Soybeans are priced in cents per bushel and soyoil is priced in cents per pound. From one bushel of soybeans, on average 11 pounds of oil[3] can be extracted. The spread should therefore be calculated as shown in equation 1 below:

$$S_t = P_{SB} - (11 \times P_{SO}) \qquad (1)$$

where:

S_t = Price of spread at time t (in cents per bushel)

P_{SB} = Price of soybean contract at time t (in cents per bushel)

P_{SO} = Price of soyoil contract at time t (in cents per pound)

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