

# C I N T R A F O R

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## Time Series Methods for Commodity Price Forecasting: An Application to Market Pulp

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### Introduction

*PULP (pulp) n. 1. A soft, moist, shapeless mass of matter. 2. A magazine or book containing lurid subject matter and being characteristically printed on rough, unfinished paper.*

*American Heritage Dictionary, New College Edition (1993)*

Many commodity products have similar characteristics. They are relatively homogenous products that can be produced using readily available technology, and are traded internationally on competitive markets. They are based on natural resources, the availability of which is subject to shocks. They are intermediate inputs with few short-term potential substitutes. As a result of these characteristics, commodity prices tend to be volatile.

Market pulp is in many ways a typical commodity. It also has some particular characteristics that contribute further to price volatility. These include high capital intensity, long-lived capital equipment, and speculative inventory management behavior on the part of consumers. Because of this volatility, accurate forecasting of market conditions is a difficult but potentially very useful exercise. Investment decisions are made on the basis of price forecasts, and improving their accuracy can lead to better decision making on the part of producers. This may in turn reduce the volatility of prices.

Considerable energies are devoted to the task of forecasting pulp prices. A number of recognized short-term leading indicators for price movements exist, and these are widely studied by industry participants. However, less attention is paid to forecasts of the more distant future. This is surprising, given that the relevant time horizon for some of the most important decisions made by the industry (namely, investments in new capacity) is at least five years. This may perhaps be explained by a relative dearth of useful long-term leading indicators on which to base forecasts. The purpose of this research is to contribute to our understanding of how the market functions and to our ability to forecast market conditions, in both the short term and the long term.

- The first step in achieving this is to identify the most important causal factors in determining market conditions. This is done by means of a survey of existing literature and discussion with industry experts. The focus of this survey is on prices and the variables that interact with prices.
- The second step is to assess how best to model these factors in such a way as to be useful for forecasting purposes. Initially, it was intended that this be done using structural methods, focusing particularly on forecasting investment levels (and then prices). In the course of developing the research proposal, however, it became apparent that recently developed time series methods provided a superior means to this end.

Since the late 1980s, time series econometrics has undergone something of a revolution. Two key concepts are non-stationarity and cointegration. Broadly speaking, the first of these refers to a variable which does not have a fixed trend, and the second refers to two or more such variables moving 'in parallel' in the long term. Non-stationarity occurs when a variable is subject to stochastic shocks that have permanent effects on it. It has been

recognized that many economic variables (including commodity prices) do exhibit non-stationarity, and it has been found that previously used methods based on the assumption of stationarity are not valid for modeling such variables. Methods have been developed to test for non-stationarity, and to model systems of non-stationary variables.

Cointegration methods provide a means for the modeler to take advantage of the effective treatment of short-term dynamics which time series models provide, while ensuring that long-term forecasts have sensible properties. The concept of cointegration is an intuitively sensible one. A pair of variables is said to be cointegrated if they have a tendency to maintain a fixed 'equilibrium' relation to one another over the long term. In a stable cointegrating relationship, the variables will adjust to eliminate any divergence from this equilibrium. Such relationships make a great deal of sense for several variables of relevance to the present case, and forecasts for these variables which show significant and long lasting violations of these relationships are not plausible. Cointegration methods allow us to test for and model the existence of long-term equilibrium relationships between the variables in a system, within the framework of a dynamic time series model. A focus of this research is to assess whether these methods prove to be of practical use for building forecasting models.

One difficulty encountered in this research is that little previous time series research on pulp markets has been published. We are therefore obliged to adopt an incremental approach to model building. First, the time series characteristics of pulp prices themselves are explored. We then develop a series of multivariate time series models. These models will attempt to capture some of the short-term and long-term processes that are thought to determine prices. The success or failure of each model will be judged according to three criteria:

- Its statistical acceptability as a representation of the data generation process;
- The plausibility of its estimated coefficients;
- And its out of sample forecasting performance.

Forecasting performance is assessed both on the basis of a formal measure of forecast error, and on an informal assessment of the desirability of the properties of the forecasts.

While these models are designed for forecasting purposes, they may also be used to an extent for structural analysis. This research is not designed primarily to test any specific behavioral hypotheses, but where convenient, structural analysis will be used to provide insights into how the market functions.

The structure of this thesis is as follows. A description of the pulp market is provided in Chapter 1. This outlines the short-term and long-term dynamics of the market. It also addresses the issue of how the 'market' should be defined in terms of its product and geographical scope. Chapter 2 provides a brief overview of the econometric concepts mentioned above, along with a description of relevant modeling methods. Data availability for the variables found to be of importance is addressed in Chapter 3. The core of the research, which consists of the estimation and testing of several models of pulp prices and other variables, is described in Chapter 4. The forecasting performances of the different models are compared in Chapter 5. Chapter 6 concludes.

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