# Forecasting Share Prices using Box-Jenkins methodology

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## ABSTRACT

Share Market efficiency has been extensively tested in financial and economics literature since the 1960's. Most of this research supports the weak and semi-strong efficient market hypothesis. However Umstead (1975) and (1977) found that aggregate quarterly share prices are inefficient enough so that application of Box-Jenkins Time Series techniques to publicly available information could have permitted an investor to earn an excess or "above average" portfolio return.

This study udertakes a similar statistical investigation of aggregate quarterly share prices in a New Zealand setting (using the Reserve Bank of New Zealand Index ). The period covered by the study is March 1961 to December 1986 i.e. a total of 104 Quarterly observations.

Initially, a univariate ARIMA model is built. Model parameters are estimated using only the first 76 observations (Mar 1961 - Dec 1979), and tested using the most recent 28 observations (Mar 1980 - Dec 1986). The model is evaluated (a) by computing a predicted $R^2$, over the test period, (b) by observing the "hit rate" for correct and incorrect trading decisions, and (c) by constructing suitable trading rule tests - i.e. simulating the results of three alternative portfolio strategies which could have been followed in the test period.

The model is found to be successful at forecasting share price changes one quarter ahead, when compared with a naive forecast.

The following conclusions are reached:

(i) The sequence of aggregate quarterly share prices is not best described as a Random Walk but rather as a seasonal moving average ARIMA process.

(ii) The sharemarket is efficient to the degree that significant trading benefits could not have been made over the test period utilising only publicly available information of previous prices (in the presence of 5 % round trip transaction costs and taxation).

These conclusions appear to support Fama's definition of a weak-form efficient market.

The latter section of the study is an attempt to build a Transfer Function Model relating changes in a leading indicator of business activity to subsequent changes in share prices i.e. use is made of other publicly available information besides historical share prices (testing the semi-strong form of the hypothesis).

A likely input series is the Money Supply as measured by M1 and/or M2. Cross (1985) provides a detailed review of empirical studies examining the relationship of share prices and Money Supply; his own results indicate that past changes in Money Supply appear to be significantly related to current share prices for the 1960 - 1982 period (S&P 500 Index on New York Stock Exchange)

It was not possible in the present study to construct an adequate Transfer Function Model which dynamically relates the two series and the conclusion reached in this study is:

The empirical results indicate that Money Supply (as measured by M1 or M2) do not significantly lead share price changes (as measured by the RBNZ Index).

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# CHAPTER ONE

## Introduction

### 1. Background

The New Zealand sharemarket is an institution of considerable interest and importance to both Public and Private Sector alike. It generates, with regularity, a large mass of fairly reliable statistical material, which is readily available for analysis. Price data are usually of high quality and are easily available.

Granger and Morgenstern(1970) observe that until the 1960's most analysis of sharemarket prices was of a rather flimsy nature. Attempts to develop models on share prices using modern statistical methodology began to surface in the 1960's and 1970's, with economists investigating wide-ranging aspects of the market's performance.

The present study restricts attention to two economic assertions:

1. Future share prices (in their aggregate as represented by an Index) are predictable in a practically useful manner from their previous, mostly cyclical movements.

2. The price movements on the sharemarket in their aggregate are a predictor of, or are predicted by, fluctuations in the economy as a whole.

A review of research findings pertinent to the present study is presented in Chapter 2. Implicit in assertion 1 above are the following common beliefs:

(a) There are seasonal or cyclic variations in share prices e.g. there is a "year-end" price rise.

(b) Share prices can be predicted from "technical analysis" of price charts.

(c) It should be possible to predict future prices from past prices i.e. after suitable manipulation of data, regularities disclose themselves.

In this study, an empirical investigation of assertion 1 is carried out (Chapter 6). In particular, a Box-Jenkins approach to modelling is employed. A brief introduction to this topic is given in Chapters 3, 4, 5.

Implicit in assertion 2 i.e. sharemarket price cycles lead or lag general economic development, is the belief that one or more indicators of business activity can be used to forecast share prices more accurately. This is empirically investigated in Chapter 8 using the Box-Jenkins methodology to build a transfer function model relating changes in the money supply to subsequent share price changes.

## 2. Motivation

Professor D.A. Umstead(1975)(1977) developed and tested a model using quarterly data from the Standard and Poors (S&P) 500 Index from 1948-1974. He lists the following conclusions:

" The sequence of aggregate quarterly stock prices is not best described as a random walk, but rather as a sixteen quarter autoregressive model with drift. Stock prices are systematically related to leading elements of economic activity. Equity markets are inefficient to the degree that significant trading benefits could have been made over an extended period in the presence of 4% round trip transaction costs, utilizing only publicly available information." ....(Umstead 1975 p.4)

## 3. Objective of the Study

To examine empirically the issues raised by the following questions:

1. Is the sequence of share prices a Random Walk?

2. How efficient is the sharemarket in adjusting to new information?

3. Can share prices be forecasted successfully?

4. Are share price fluctuations related systematically to economic activity (as measured by Money Supply)?

The approach taken by Umstead (1975) & (1977) will be followed (with some modification), using historical data from the New Zealand Stock Exchange. Only a portion of the data is used in the model-building process. The remainder, retained as a "hold-out" sample, is used in attempting to simulate results of three alternative portfolio strategies:

Portfolio 1:

Buys-and-holds the sharemarket index for the test period.

Portfolio 2:

Switches between a fixed-interest rate investment and the sharemarket.

Portfolio 3:

Buys a fixed-interest rate security each quarter.

The switching decision is based on a comparison of the forecasted quarterly holding period return for equities with the forecasted (and actual) return for a fixed-interest investment.