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# **Time Series Analyses of Inflation in New Zealand**

A THESIS PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
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AT MASSEY UNIVERSITY

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## **ABSTRACT**

Modelling of the economy has become increasingly important over the years. It serves two main purposes. It enables forecasts and it can be used for the evaluation of various economic policies. Economic models come with various degrees of size and statistical complexity. Models can be of a qualitative or of a quantitative nature. The soundness of the statistical techniques that are used for quantitative models is critical. In recent years a number of such techniques have been developed. This thesis will evaluate some on existing economic New Zealand time series.

Inflation plays a main role in everyday life and it has been of major ongoing concern to the New Zealand governments in recent times. These governments have instructed the Reserve Bank of New Zealand (RBNZ) to set monetary policies to ensure certain targets are met. The RBNZ achieves this to a large degree by setting the Official Cash Rate which is the major determinant of the interest rates that are used by the banks.

This thesis will consider some theoretical aspects of time series analysis. In particular the Dickey-Fuller tests and cointegration analysis are considered. Also some theoretical aspects of inflation are considered. Examples are given of aspects of New Zealand life other than the interest rates that may also affect the current inflation rates.

The time series that were analysed could be categorised as inflation indices, monetary aggregates, interest rates and gross domestic product. The thesis attempted to evaluate the time series in such a manner that there was little room for an analyst's bias. This was mainly achieved by developing a standardised approach to the analysis of these series. A number of interactions between the time series were evaluated and some were identified as being suitable for further research with the ultimate aim of developing a small model of the New Zealand economy. Another aim was to evaluate some aspects of economic policy where possible given the small number of time series that were used. Granger

Causality tests seemed to show the effect of economic policy, where the interest rates affect the inflation rates. However, this was not further supported by cointegration analyses. There are various possible explanations for this. It was surmised that the standardised way of analysis may not have identified this relationship where it existed.

The analyses showed that at times the results of the statistical tests were inconsistent. This applied to the Dickey-Fuller tests as well as the cointegration analyses. In some cases unit root models with significant coefficients for the deterministic components were identified. Further analysis would show that the deterministic components were not significant after all. However, the resulting models without these components did not have a unit root. The cointegration analyses invariably showed a number of Vector Error Correction Models with significant cointegration equations. Since their economic implications would be quite different at times there was a reason for concern.

In conclusion there are some worrying problems when the methodology is used for existing short New Zealand data series. However, at times some plausible results were shown as well. Suggestions for further research were made.

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## NOTATIONS

### Abbreviations of statistical terms

|                     |   |
|---------------------|---|
| * (**)              | denotes rejection of the hypothesis at the 5% (1%) significance level |
| AIC                 | Akaike Information Criterion  |
| ACF                 | Autocorrelation function  |
| ADF                 | Augmented Dickey-Fuller test statistic                                |
| Adj. R <sup>2</sup> | Adjusted R-squared value  |
| CE                  | Cointegrating Equation  |
| DF                  | Dickey-Fuller   |
| GC                  | Granger Causality   |
| IRF                 | Impulse Response Function   |
| n                   | Sample size   |
| k                   | number of parameters  |
| p                   | P-value   |
| RSS                 | Residual Sum of Squares   |
| SC                  | Schwartz Criterion  |
| SD                  | Standard Deviation  |
| SE                  | Standard Error  |
| T                   | Number of usable observations   |
| VAR                 | Vector Autoregression   |
| VD                  | Variance Decomposition  |
| VECM                | Vector Error Correction Model   |
| $\gamma$            | Coefficient of ADF test statistic                                     |
| $\tau$              | Various $\tau$ statistics (See Chapter 2)                             |
| $\phi$              | Various $\phi$ statistics (See Chapter 2)                             |

### Abbreviations of economic terms

|       |  |
|-------|--|
| CD    | Call Deposit Rate  |
| CPI   | Consumer Price Index   |
| CPINT | CPI Non-Tradable Inflation   |
| CPIT  | CPI Tradable Inflation   |
| CPIX  | CPI excluding credit services  |
| EGDP  | Expenditure-based real Gross Domestic Product in 1995/96 million dollars   |
| GDP   | Gross Domestic Product   |
| HE    | Average Hourly Earnings  |
| LC    | Labour Cost Inputs   |
| M1    | Notes and coins held by the public plus chequeable deposits, minus inter-institutional chequeable deposits, and minus central government deposits.   |
| M2    | M1 plus all non-M1 funding (call funding includes overnight money and funding on terms that can of right be broken without break penalties) minus inter-institutional non-M1 call funding. |

|       |  |
|-------|--|
| M3    | Notes and coins held by the public plus NZ dollar funding minus inter-M3 institutional claims and minus central government deposits. |
| M3(R) | Same as M3, less funding from non-residents.   |
| M2R   | M2 – M1  |
| M3RR  | M3(R) – M2   |
| NT    | CPI Non-Tradable Inflation   |
| OCR   | Official Cash Rate   |
| PGDP  | Production-based real Gross Domestic Product in 1995/96 million dollars  |
| RBNZ  | Reserve Bank of New Zealand  |
| SMD   | Six Month Deposit Rate   |
| T     | CPI Tradable Inflation   |

### Prefix or Suffix

Time series may have undergone some statistical manipulations. This is usually indicated by a prefix or suffix

|          |                                       |
|----------|---------------------------------------|
| A        | Suffix for CPI adjustment             |
| D        | Prefix for differenced time series    |
| LOG      | Prefix for logarithmic transformation |
| SA       | Suffix for seasonal adjusted          |
| $\Delta$ | Prefix for differenced time series    |

Note that in some cases a transformed time series may be displayed in equations without its prefix or suffix. This was done to keep the equation concise and it will be explained when it occurs.

### Typeface

|                              |   |
|------------------------------|---|
| Italics                      | Denotes time series   |
| Bold in cointegration tables | Denotes optimal model according to SC and AIC   |
| Bold in equations            | Denotes significant coefficients based on availability of relevant statistics. Note that the standard error is not always available (see Table 2.5) |

# CHAPTER 1

## GENERAL INTRODUCTION

### 1.1 The importance of inflation

“Inflation is the one form of taxation that can be imposed without legislation”  
(Quote from Milton Friedman)

Inflation is the increase of price levels. It can be measured for a multitude of baskets of goods and services. Examples of inflation measures are the commonly used Consumer Price Index (CPI) and the Producers Price Index (PPI). Inflation means that the basket of goods and services becomes more expensive when expressed in nominal dollars as time goes by. Nominal dollars are dollars used currently, without any inflation adjustment.

There is a perception that inflation is bad. Since inflation will generally not be the same for all goods and services, the relative prices for the different goods and services may change. This may be a beneficial process from a resource allocation perspective. It is not surprising that people will regard inflation as negative if they pay more for their goods and services and they are on fixed incomes. From a rational perspective, this negative perception should not be the case if their income increases at a level that compensates for inflation, ie if their purchasing power is maintained. Successive New Zealand governments have arguably made considerable attempts to keep inflation within certain bounds but their objective has not been a zero rate of inflation.

Inflation can lead to a redistribution of income and wealth. Interest rates are of particular relevance. A lender will be worse off and a borrower will benefit if interest rates do not include sufficient compensation for inflation. The use of tax brackets where higher tax rates apply if income exceeds certain nominal levels are a clear reason why inflation is perceived as a negative event.

Even if there is compensation for inflation, there may still be a negative perception since inflation will create uncertainty regarding the purchasing power of incomes and investments or debt. This is especially the case for high levels of inflation and there can be little doubt that high inflation is undesirable. What precisely determines the optimal level of inflation is not a trivial question.

### 1.2 Current issues in New Zealand

In the 1980's New Zealand experienced high inflation rates. Since then various governments have been committed to reduce the inflation rates to lower levels and to keep it at these levels. The interest rates that currently (February 2004) exist seem to be considered low if one

considers the flourishing market for houses and mortgages. Similarly they are beneficial for those who wish to borrow for investment in plant and equipment.

The Reserve Bank of New Zealand (RBNZ) sets the Official Cash Rate (OCR) which determines the interest rates charged by banks to their customers. The main criterion of the RBNZ is to ensure that the CPI remains within certain bounds as agreed to with government. If the RBNZ believes that the CPI will become too high it will increase the OCR thereby reducing demand. If, on the other hand, it believes the CPI will become too low it will lower the OCR. Currently (2004) the RBNZ believes the housing market is overheating and is putting too much pressure on the inflation rates. Consequently there is an incentive for the RBNZ to increase the OCR.

The combination of interest rates and expected inflation are important factors for establishing the exchange rates. An increase of the exchange rate will be detrimental to exporters and beneficial to importers. At the time of writing (2004) the US dollar has depreciated considerably in recent months in value against many currencies including the NZ dollar. Much of the international trade is carried out with US dollars and consequently many exporters would like to see a decrease in the OCR.

The two conflicting pressures described above results in the RBNZ's unenviable position. Whatever its decision, there is likely to be severe criticism. It raises the question whether the reliance on one tool only (the OCR) to deal with multiple objectives is too limited.

### **1.3 The use of statistical techniques to analyse inflation**

The analysis of historic data seems a prerequisite for making rational decisions. In this case statistical techniques will be used to analyse inflation rates and other variables that may influence inflation. These variables include monetary aggregates, interest rates and the Gross Domestic Product. Without a doubt there are other factors that affect inflation as well. Examples are the exchange rate and unemployment. However a full analysis of all possible factors that affect inflation is beyond the scope of this thesis.

Time series analysis will be used to analyse the datasets. Initially analyses will be carried out at the univariate level and they will be followed by multivariate analyses to evaluate possible interactions.

An important aspect of time series analyses is whether they are stationary or not. A full explanation will follow in a later chapter but crudely speaking lack of stationarity means that the mean and variance of the series vary over time. In the late 1970's techniques were developed to evaluate this aspect. Since the late 1980's a number of techniques have been developed to analyse the interaction of time series that are not necessarily stationary.

The explanation in some publications of a number of the currently used time series techniques is not always clear and what appear to be mistakes may at times be detected. These mistakes may be 'typographical' but they may also be the result of a theory that sometimes appears confusing (at least to the author of this thesis). The time series that are commonly used in the area of econometrics are generally of short duration. This combined with the small power of some of the tests, results in difficulties when attempting to analyse these series. Like other

statistical tests, the tests discussed in this thesis require assumptions of a statistical nature before they can be used. In addition diagnostic checking is required to ensure that the results are valid. Therefore there are a number of issues that need to be addressed before one can confidently draw conclusions regarding economic time series that are valid from a statistical perspective. This thesis attempts to describe in a clear and consistent way some of these issues and will analyse some time series taking these limitations into account. It does not claim to be able to give a definitive conclusion on what is wrong and what is right.

The findings of the analyses will depend heavily on the assumptions made. Where possible these assumptions will be explicit. An issue arises where the data are collected under certain policy regimes. If these regimes change, the findings of the analyses may no longer be applicable. In a sense the existing policies, where not clearly described as variables, are implicit assumptions. This means that one has to be careful when generalising results.

Once the analyses have been performed the results can be used for developing models. The two main purposes of these are policy analysis and forecasting. Policy analysis allows the evaluation of 'what-if' scenarios while forecasting attempts to predict what the future will bring. It has been claimed that generally a model can only be used for either of these two purposes but not for both at the same time.

#### **1.4 The structure of this thesis**

The key questions in relation to inflation are:

- What causes inflation?
- What is the appropriate level of inflation?
- How can the appropriate level of inflation be achieved on an ongoing basis?

In order to answer the last question one should, at least, attempt to answer the first question. The main purpose of this thesis is to find an answer to the first question. There are no guarantees that the approach taken will provide the answers, if only because other factors that might drive inflation are not analysed in this thesis. However, it is maintained that the approach taken is a minimum requirement to deal with questions relating to inflation.

The key research questions for this thesis fall in two categories: They are the statistical ones and the economic ones.

Various economic models exist. The key economical research questions are:

- 1 Can equations be found that could serve as a backbone for a small model of the New Zealand economy for the period in question?
- 2 Can economic and monetary policy be seen reflected in the data sets (eg do interest rates rise as inflation rises)? More importantly perhaps is the question whether economic or monetary policies are successful.

The statistical techniques discussed in this thesis are used widely. The key statistical research questions are:

- 1 How well do standard cointegration techniques work under practical conditions? Policy changes that may affect relationships and trends of time series occur relatively frequently in practice. Consequently it will often be more appropriate to evaluate short

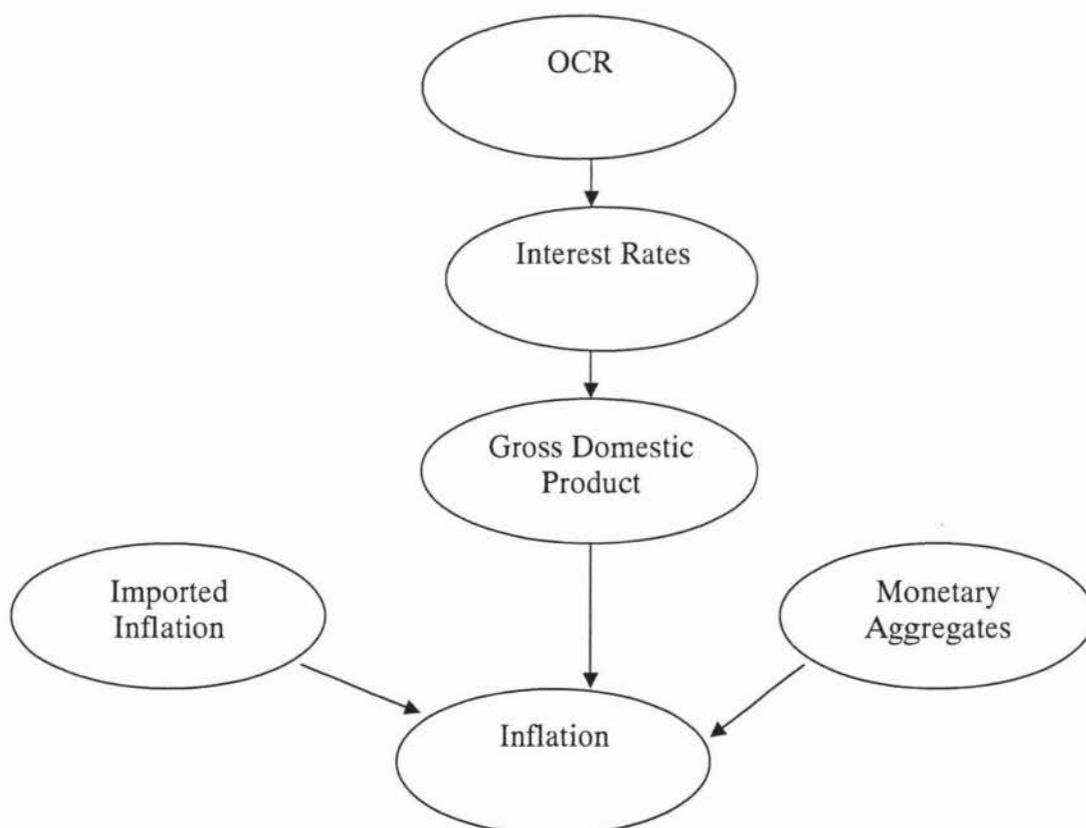
time series rather than long ones. New Zealand series of approximately ten years are used to evaluate this issue.

- 2 Can an automated approach involving the examination of a large number of possible models produce sensible results? Sensible can be interpreted as meaning that the results of the various models should not contradict each other. In addition the final result of a model, ie a group of equations, should preferably cover the area of interest in a coherent manner

Sometimes data analysis is performed and only a limited number of the possible models will be displayed. This thesis attempts to demonstrate the large number of options that might be possible at times. The drawback of the selective approach of only showing a limited number of models is that they may be heavily influenced by the analyst's economic views. Alternative equally plausible models may be ignored unintentionally; the analyst just did not test for it. Therefore different views of economic theory might lead to different admissible models according to some commonly used statistical techniques.

The analysis will be performed in the New Zealand context. The emphasis of the thesis will be on the use of certain statistical techniques when analysing economic time series. Although economic theory will be considered the focus will mainly be on the use and limitations of these statistical techniques. This is because it will provide insights into the validity of conclusions when statistical techniques are evaluated in-depth.

**Figure 1.1** Schematic overview of factors affecting inflation that are evaluated in this thesis



The following two chapters will discuss theoretical aspects of time series analysis (Chapter 2) and of inflation (Chapter 3). Chapter 4 will analyse inflation time series. Chapter 5, 6 and 7 will evaluate monetary aggregates, interest rates and GDP respectively. This will first be at a univariate level followed by multivariate techniques. Figure 1.1 provides an overview of the interaction of these variables.

Currently the understanding of inflation in New Zealand relies heavily on this country having its own currency, the New Zealand dollar. International communications are continually improving and differences between countries are becoming increasingly smaller. If currency substitution (ie the use of other currencies for trade within New Zealand) became a commonly accepted practice, the dynamics of inflation might change. A final chapter is dedicated to currency substitution and various ramifications for the New Zealand economy.