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Selecting appropriate methodological framework for time series data analysis☆

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Abstract

Economists face method selection problem while working with time series data. As time series data may possess specific properties such as trend and structural break, common methods used to analyze other types of data may not be appropriate for the analysis of time series data. This paper discusses the properties of time series data, compares common data analysis methods and presents a methodological framework for time series data analysis. The framework greatly helps in choosing appropriate test methods. To present an example, Nepal's money−price relationship is examined. Test results obtained following this methodological framework are found to be more robust and reliable.

Keywords: Time series analysis; Unit root test; Methodological framework; Money−price relationship in Nepal

1. Introduction

Time series data is a sequence of observations of the defined variable at a uniform interval over a period of time in successive order. Most common series are in annual, quarterly, monthly, weekly and daily frequencies. Economic time series data often possess unique features such as clear trend, high degree of persistence on shocks, higher volatility over time and meandering and sharing co-movements with other series.[1] Researchers need to understand such features of time series data properly and address them.

In time series analysis, it is important to understand the behavior of variables, their interactions and integrations over time. If major characteristics of time series data are understood and addressed properly, a simple regression analysis using such data can also tell us about the pattern of relationships among variables of interest. This paper attempts to highlight the basic econometric issues related to the time series data and provides a basic methodological framework for time series analysis. In addition, the paper analyses the relationship between money and price in Nepal using the methodological framework presented in this paper to provide practical example.

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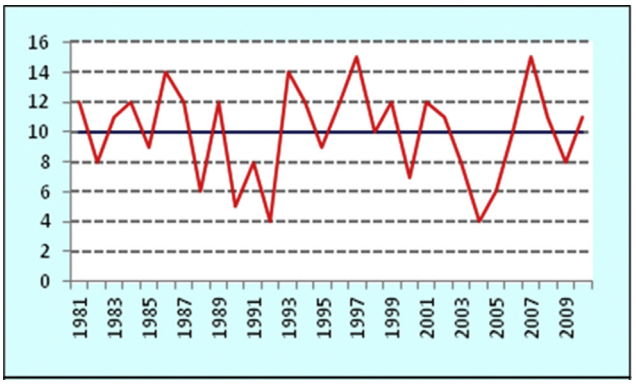

Fig. 1. Stationary time series.

2. Properties of time series data

2.1. Autoregressive character of time series

Time series data may have some kind of relationship with its previous values. The autoregressive (AR) character of time series model indicates that present value of any variable is determined by its past value and some adjustment factors. Such adjustment factors are estimated from the relation of current value with past values. If the current value is based solely on the immediate preceding value, it is termed as first order autoregressive, AR (1), and if it is based on two preceding values, second order autoregressive, AR (2), and so on.

A univariate linear regression model[c] can be estimated as:

$$Y_t = \mu + \rho Y_{t-1} + \varepsilon_t \tag{1}$$

where, Y_t is a dependent variable, Y, at period t. μ is a constant parameter. ε_t is the unexplained part (gap) of actual data and fitted line by regression equation, termed as error. Y_{t-1} is the first lagged value of Y, ρ is the coefficient of Y_{t-1}.

Eq. (1) says that the value of Y_t equals the constant μ plus ρ times its previous value and an unknown component ε_t

The model to be estimated in Eq. (1) is an AR (1) process.

Similarly,

$$Y_t = \mu + \rho_1 Y_{t-1} + \rho_2 Y_{t-2} + \varepsilon_t \tag{2}$$

The model to be estimated in Eq. (2) is an AR (2) process.

Besides the AR process, moving average (MA) model also estimates the present value of a variable based on the current and previous years' error terms.[d] As in AR process, there can be more than one order of integration in MA as well.

2.2. Stationary and non-stationary series

A time series data is called stationary if its value tends to revert to its long-run average value and properties of data series are not affected by the change in time only (Fig. 1).[e] On the contrary, the non-stationary time series does not tend to return to its long-run average value, hence, its mean, variance and co-variance also change over time (Fig. 2).

Most of the macroeconomic variables such as volume of gross domestic product (GDP), consumption, consumer price index, etc. exhibit a strong upward or downward movement over time with no tendency to revert to a fixed mean.

[c] For details, see Stigler (1981).[2]

[d] Error terms are the unobserved factors of regression that may affect the dependent variable. These are residuals of actual and fitted values of a regression. It is represented by ε or u. Wooldridge (2002) mentions that "dealing with this error term is the most important component of any econometric analysis".

[e] For details, see Verbeek (2017)[3], Chapter 8.

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