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Ten Things We Should Know About Time Series

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WORKING PAPER

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Abstract

Time series data affect many aspects of our lives. This paper highlights ten things we should all know about time series, namely: a good working knowledge of econometrics and statistics, an awareness of measurement errors, testing for zero frequency, seasonal and periodic unit roots, analysing fractionally integrated and long memory processes, estimating VARFIMA models, using and interpreting cointegrating models carefully, choosing sensibly among univariate conditional, stochastic and realized volatility models, not confusing thresholds, asymmetry and leverage, not underestimating the complexity of multivariate volatility models, and thinking carefully about forecasting models and expertise.

1. Introduction

The broad area of spatial econometrics and statistics contains time series as a special case, wherein the space dimension is defined as time.

Time series analysis is crucial to the understanding of movements of variables over time in the social, physical and medical sciences.

When asked about the meaning of life, the Dalai Lama was reported to have said that it was to be happy.

In "Of Human Bondage" (by Somerset Maugham), Peter Carey decided there was no meaning to life.

Although there is no definition of the meaning of life that will satisfy everyone, many would agree that a functional specification would almost certainly involve a time series dimension, such as an AR(1) process.

Truisms such as "The old wheel turns and the same spoke comes up", "We live, we pay taxes, we die", and "The only certainties in life are death and taxes", almost certainly arose through observing historical patterns in time series data.

The purpose of this paper is to highlight ten things we should all know about time series, which should assist in understanding time series data, and maybe even some key issues in life.

2. Ten Things We Should Know

(1) Knowledge of Econometrics and Statistics is Essential

Time series analysis can be quite complicated, especially at the multivariate level, so one should come prepared with an appropriate technical background. The benefits of

having a good working knowledge of econometrics and statistics for analysing economic and financial time series data will become readily apparent.

(2) Be Aware of Measurement Errors

Measurement errors can be prevalent in measuring data in the social sciences. Few variables are measured correctly, whether at low, high or ultra high frequencies, so be aware of the likely presence of measurement errors which can affect estimation, testing, forecasting, and any subsequent analysis.

(3) Test for Zero Frequency, Seasonal and Periodic Unit Roots

Many time series at various frequencies, especially in economics, are non-stationary. It pays to be aware of the implications of the presence of zero frequency, seasonal and periodic unit roots, how to detect them, especially in the presence of structural change, and how to deal with them once they have been detected.

(4) Analyse Fractionally Integrated and Long Memory Processes

Time series data may have no memory (static models rather than dynamic), short memory (moving average processes), exponential decay (autoregressive processes), infinite memory (unit roots), or long memory (fractionally integrated processes). Many time series in economics and finance possess long memory, which can be modelled by fractionally integrated models.

(5) Estimate VARFIMA Models

Many multivariate time series can be explained using vector ARFIMA models or their seasonal variants. There are numerous variations of fractionally integrated ARMA models, and choosing among them is not always entirely straightforward. The application of various diagnostic checks can prove useful.

(6) Use and Interpret Cointegrating Models Carefully

When time series processes are non-stationary, one or more cointegrating relationships may explain how the variables move together over time. It is easy to misunderstand the meaning and interpretation of cointegrating models, especially as alternative models are non-nested (such as either the levels or logarithms of a variable being tested under the null as I(1)), so cointegration tests should be used carefully.

(7) Choose Sensibly Among Univariate Conditional, Stochastic and Realized Volatility Models

Financial data have returns that may be unpredictable, but their volatility can be modelled as stationary processes and forecasted for purposes of risk management and forecasting Value-at-Risk. There are some similarities but many differences among alternative univariate and multivariate conditional, stochastic and realized volatility models, so care should be exercised in choosing from the portfolio of alternative volatility models.

(8) Do Not Confuse Thresholds, Asymmetry and Leverage in Volatility

Alternative models may have symmetric, asymmetric, leverage or threshold effects on volatility arising from positive and negative shocks of equal magnitude. It is easy to confuse asymmetry and leverage, in particular, even for univariate processes, but especially for their multivariate counterparts. This confusion is evident in textbooks, and sometimes in widely used econometric software package, which will lead to misinterpretation in empirical analysis.

(9) Do Not Underestimate the Complexity of Multivariate Volatility Models

Extensions of univariate volatility processes to their multivariate counterparts can be very complicated from the theoretical, statistical and computational perspectives. Not all models are created equal. Not all multivariate volatility models make sense, especially in terms of leverage, and time-varying covariances and correlations.

(10) Think Carefully About Forecasting Models and Expertise

One of the primary purposes in modelling time series data, especially in economics and empirical finance, is to provide accurate forecasts. The models underlying forecasts should be investigated carefully, especially if they are given by experts, who frequently emphasize their own expert knowledge and intuition in obtaining necessarily biased non-replicable forecasts, over replicable forecasts, which would be based on an econometric model, which can lead to unbiased forecasts. Sometimes such reliance on expertise may be warranted, but at other times it is not.

3. Conclusion

There are many things in life that can be tiring and bothersome. Leamer (1988) lists ten such "bothers". McAleer (1997, 2005) and McAleer and Oxley (2001, 2002, 2005) suggest ten commandments that should be followed in organizing a conference, attending a conference, presenting a conference paper, for academics, and for ranking university quality. Most of these commandments are routinely ignored, in practice, but that does not make the need to emphasize them any less compelling.

Nevertheless, we cannot ignore the fact that "We live, we die."

We should also not ignore the ten things we should know about time series.

Acknowledgements

References

Leamer. E.E. (1988), Things that bother me, *Economic Record*, 64, 331-335.

McAleer, M. (1997), The Ten Commandments for organizing a conference, *Journal of Economic Surveys*, 11, 231-233.

McAleer, M. (2005), The Ten Commandments for ranking university quality, *Journal of Economic Surveys*, 19, 649-653.

McAleer, M. and L. Oxley (2001), The Ten Commandments for attending a conference, *Journal of Economic Surveys*, 15, 671-678.

McAleer, M. and L. Oxley (2002), The Ten Commandments for presenting a conference paper, *Journal of Economic Surveys*, 16, 215-218.

McAleer, M. and L. Oxley (2005), The Ten Commandments for academics, *Journal of Economic Surveys*, 19, 823-826.