Analysis And Evaluation of Econometric Time Series Models: Dynamic Transfer Function Approach

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This paper presented how to apply a set of response variables and a set of explanatory variables by using systems of equations of regression models as well as the same set of variables modeled by Dynamic Transfer Function (DTF) model, in order to compare degrees of accuracy and interrelation between such variables. We study a macro econometric forecasting system employed by the Accounting and Statistics of Annual Bulletin published by Central Bank of Sri Lanka. We shall use this study to illustrate the problems with the inclusion of contemporaneous input variables in the identification of a transfer function model and their effects on the forecasting performance of the model. Following the methods are developed by the author. The data used in this study began in the first quarter of 1991.
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Abstract: In the application of large scale econometric models for forecasting, the single-equation ordinary least squares (OLS) method is often used to estimate parameters in each model equation. This paper investigates the properties of the parameter estimates under single-equation estimation methods. Since the residuals of a time series regression model is seldom a white noise process, it is found that bias is almost inevitable as long as endogenous variables are present in a model equation. This paper proposes a model identification method based on reduced form Dynamic transfer function (DTF) models that can avoid the bias of transfer function weight estimates under rather practical assumptions. It is found that forecasts can be greatly improved if appropriate models are identified and employed.

Introduction

The development and application of time series analysis in econometric forecasting has occurred rapidly during the past two decades. In recent years, the focus in this area has shifted from univariate or single equation to multivariate and simultaneous equation models. Despite vast advancements in the development of econometric time series modelling, "classical" econometric models are still one of the major tools used by many commercial economic forecasting firms to provide national economic forecasts. In this section "classical" econometric models are considered as the simultaneous equation systems and Klein (1950), and studied extensively by a number of econometricians. In typical applications of the classical econometric models, a simultaneous equation system often consists of a set of linear lag regression equations with white noise. For typical national economic forecasting systems, the number of variables and equations included in the systems is often large. Therefore it is impossible to perform a joint parameter estimation of the full system as recommended in modern time series econometric models. Even though the classical econometric model is often referred to as a system of equations, it is important to note that in typical applications of large scale econometric models, the use of "system" or "joint model" comes in at the forecasting stage, rather than at the model estimation stage. In terms of model estimation, the ordinary least squares (OLS) method is usually applied to each equation in the system individually. In such a case, a large system of equations is merely a collection of single-equation linear regression or lag regression models as far as model estimation is concerned. Since the single equation OLS estimates may have serious bias, the accuracy of forecasts based on such biased estimates is dubious. A number of alternative methods, such as ARIMA and DTF have been studied extensively. However, such methods in practice can only be applied to a small system of equations with white noise.
The usefulness of large scale econometric models has been subject to many criticisms, particularly, the validity of the models and their forecasting performance. In this paper we consider an extension of classical econometric models that may avoid some drawbacks in modelling and improve the forecasting performance of the models. In addition, we investigate the issue of tentative model identification in econometric time series modelling. Since the properties of parameter estimates and the accuracy of forecasts based on the assumption that the form of the model is correctly specified, the importance of model identification is apparent.

In this paper, the use of Dynamic transfer function (DTF) analysis in the identification of a reduced form econometric model is proposed.

**Classical Econometric Models**

We briefly outline the framework of classical econometric models and their extensions in light of time series models. We will consider a system of equations that consists of two variables, \( y_t \) and \( x_t \), where \( y_t \) and \( x_t \) may be inter-related and both can be endogenous variables in the system. A general form of a classical econometric model for such a system can be expressed as

\[
y_t = c_1 + \frac{\omega_1(B)}{\delta_1(B)} y_{t-1} + \frac{\theta_1(B)}{\phi_1(B)} z_{1t}
\]

\[
x_t = c_2 + \frac{\omega_2(B)}{\delta_2(B)} y_{t-1} + \frac{\theta_2(B)}{\phi_2(B)} z_{2t}
\]

In classical econometric models, it is often assumed that \( z_{1t} \) and \( z_{2t} \) are independently and identically distributed as multivariate normal \( N(0, \Sigma) \), where \( c_1 \) and \( c_2 \) are the autoregressive-moving average (ARMA) operators of the disturbance term, and \( \frac{\omega_i(B)}{\delta_i(B)} \)’s are the transfer functions (Box and Jenkins (1976)), where

\[
\phi(B) = 1 - \phi_1 B - \phi_2 B^2 - \cdots - \phi_p B^p
\]

\[
\theta(B) = 1 - \theta_1 B - \theta_2 B^2 - \cdots - \theta_q B^q
\]

\[
\omega(B) = \omega_0 - \omega_1 B - \omega_2 B^2 - \cdots - \omega_g B^g
\]

\[
\delta(B) = 1 - \delta_1 B - \delta_2 B^2 - \cdots - \delta_g B^g
\]

The model in (1) and (2) is also referred to as a rational structural form (RSF) model (Wall (1976)), or a simultaneous transfer function (STF) model. In general, a k-equation STF model can be written in a compact matrix form.

**The Proposed DTF Method**

Based on the results in stepwise autoregression, we may employ DTF analysis. We shall present the results based on the maximum lag order of \( p \). In the first step of the DTF estimation, an AR(1) disturbance model is used for all three equations. In examining the
sample autocorrelation function (ACF) and partial autocorrelation function (PACF) of the residual of the above two equations. The proposed DTF models is applied to the National economic time series of Sri Lanka. We study a macro econometric forecasting system employed by the Accounting and Statistics of Annul Bulletin published by Central Bank of Sri Lanka. We shall use this study to illustrate the problems with the inclusion of input variables in the identification of a transfer function model and their effects on the forecasting performance of the model. Following the methods are developed by the author. The data used in this study began in the first quarter of 1991 and ended in the fourth quarter of 2004, a total of 56 observations for each variable. Among the 56 observations in each series, the first 52 observations will be used for model identification and parameter estimation. The last 4 observations will be used solely for the comparison of the forecasting performance of the models. One of the most important applications of this econometric model is to forecast the quarterly economic time series of Sri Lanka.

Among the dependent variables in the behavioral equations of the econometric model, we shall only include 15 of them in this study. For the variables excluded in the study, four of them are price deflation variables, two of them are tax variables, and three other variables are not easily interpretable. Since the wholesale price index (WPI) and consumer price index (CPI) are included in the study, the behavior of these two variables is representative for other price index variables excluded from this study. The tax variables are not included in the study due to the irregular variability of their seasonal patterns, which is mainly caused by changes of tax regulations. For convenience of reference, the abbreviations and definitions of the 6 dependent variables and their relevant explanatory variables are listed below. The time series plots for the 6 dependent variables (original series). All the series to be studied are nonstationary and possess strong seasonality (except a few). Note that results and time series plots are deliberately omitted because of no enough space. Those will be included in the full paper.

**CONCLUSIONS**

The analyses shown above reveal several interesting points that are worth further discussion. When the DTF analysis is employed, a number of transfer function models degenerate to ARIMA models. This result indicates that the association between the explanatory variables and the dependent variable is not as strong as the original hypotheses of the models suggested (or what the classical regression models indicated). This is not too surprising if we take the economic environment of Sri Lanka into consideration. Sri Lankan has a highly regulated economy. A number of foreign and domestic events also have had important impacts on Sri Lankan’s economy. All these factors contribute to major disturbances which might weaken the potential relationships between the dependent variables and their explanatory
variables. As the free economic environment becomes more mature and the political situation becomes more stable, we may find transfer function models more useful in modelling Sri Lankan economic time series.

References


