行政院國家科學委員會專題研究計畫成果報告

科技替代與衰退資料的預測分析
Predictive Inference for Technology Substitutions and Degradation Data

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本報告含兩篇完成之研究成果。

一、 Forecasting Technological Substitutions with Concurrent Short Time Series Using Nonlinear Models

此文利用非線性成長曲線模式對並存的短時間序列資料作科技替代預測。這是本計劃的研究主題之一。擬送到專業期刊發表。其中英文之摘要如下。

（一）、中文摘要

此論文利用非線性成長曲線模式對並存的短期時間序列資料做科技替代預測。其中共變異數矩陣Σ為 AR(1)相關結構。當應用冪次轉換於模式時，我們介紹兩種非線性建模方法。另一方面我們利用冷卻模擬方法解決最佳化問題。此外我們藉由實際資料在非線性模式與（DBT）模式間做一些預測精確性的比較。

（二）、英文摘要

In this paper we use nonlinear growth curve models for forecasting technological substitutions with concurrent short time series data when the covariance matrix $\Sigma=\sigma^2 C$ where $C=(c_{ij})$, $c_{ij}=\rho^{|i-j|}$, $-1<\rho<1$, and $\sigma>0$ are unknown. While applying power transformations, two methods of nonlinear modeling are investigated. Meanwhile, simulated annealing for optimization problem is also studied. Some comparisons in predictive accuracy between databased transformed and nonlinear models are also made via real data.

（三）本研究成果之參考文獻如下

Bertsimas, D. and Tsitsiklis, J. (1993), "Simulated annealing. ", Statistical Science, 8, No. 1, 10-15

Box, G. E. P. and Cox, D. R. (1964), "An analysis of transformations. ", J. Royal Stat. Soc. B, 26, 211-252

Cerny, V. (1985), "A thermodynamic approach to the traveling salesman problem: An efficient simulation. ", J. Optim. Theory Appl., 45 41-51.

Dawid, A. P. (1984), "Present position and potential developments: Some pesonal views. ", J. Roy. Statist. Soc. Ser. A, 147, 278-292

Fisher, J. C. and Pry, R. H. (1971), "A simple substitution Model of technological change.", Technological Forecasting and Social Change, 3, 75-88

Geisser, S. (1975), "The predictive sample reuse method with applications. ", JASA, 70, 320-328

Gompertz, B. (1825), "On the nature of the function expressive of the law of human mortality, and on a new mode of determining

the value of life contingencies. ", Philosophical Transactions of the Royal Society of London, 115, 513-585
Keramidas, E. M. and Lee, J. C. (1990), "Forecasting technological substitutions with concurrent short time series. ", JASA, 85, 625-632
Kirkpatrick, S., Gelett, C. D. and Vecchi, M. P. (1983), "Optimization by simulated annealing. ", Science, 220, 621-630
Lee, J. C. (1988), "Prediction and estimation of growth curve with special covariance structures. ", JASA, 83, 432-440
Lee, J. C. and Lu, K. W. (1987), "On a family of data-based transformed models useful in forecasting technological substitution. ", Technological Forecasting and Special Change, 31, 61-78
Lee, J. C., Lu, K. W. and Horng, S. C. (1992), "Technological forecasting with non-linear models. ", J. of Forecasting, 11, 195-206
Lee, J. C. and Tsao, S. L. (1993), "On estimation and prediction procedure for AR(1) models with power transformations. ", J. of Forecasting, 12, 499-511
Potthoff, R. F. and Roy, S. N. (1964), "A generalized multivariate analysis of variance model useful especially for growth curve problem. ", Biometrika, 51, 313-326
Rao, C. R. (1987), "Prediction of future observations in growth curve models. ", Statistic Science, 2, 434-471
Sharif, M. N., Islam, M. N. (1980), "The weibull distribution as a general model for forecasting technological change. ", Technological Forecasting and Social Change, 18, 247-256
Stapleton, E. (1976), "The normal distribution as a model of technological substitution. ", Technological Forecasting and Social Change, 8, 325-334
Stone, M. (1974), "Cross-validatory choice and assessment of statistical predictions (with discussion). "J. Roy. Statist. B, 36, 111-133
Stone, M. (1977), "An asymptotic equivalence of choice of model by cross-validation and Akaike's criterion. ", J. Roy. Statist. Soc. Ser. B, 39, 44-47
Vanderbilt, D. and Louie, S. G. (1984), "A monte carlo simulated approach to optimization over continuous variables. ", J. of Computational Physics, 56, 259-271

二、 On Modeling Data from Degradation Sample Paths over Time

此文是以預測觀點利用成長曲線模式來分析 Bogdanoff and Kozin（1985）所提的裂縫長度資料。這是本計畫的研究主題之一。擬送到國際期刊發表。其中英文摘要如下：

（一）、中文摘要

本篇論文是用成長曲線模式來分析 Bogdanoff and Kozin（1985）兩人所提的裂縫長度資料。這篇論文主要的目的是用預測觀點來比較成長曲線模式和 Lu and Meeker（1993）所提之非線性衰退模式，我們也將使用這些模式來預測斷裂時間。

（二）、英文摘要

In this paper we use the general growth curve model to analyze the crack length data from Bogdanoff and Kozin（1985）. The main purpose of this paper is to compare the proposed model with the nonlinear degradation model of Lu and Meeker（1993）from a prediction point of view. We will also compare the forecast of failure time using different models.

（三）本研究成果之參考文獻如下

Box, G. E. P. and Cox, D. R. (1964), "An Analysis of Transformation"(with discussion), journal of the Royal Statistical Society, Ser. A, 26, 211-252.

Bogdanoff, J. L. and Kozin, F. (1985), "Probalitistic Models of Cumulative Damage, New York: John Wiley.

Chi, E. M. and Reinsel, G. C. (1989), "Models for Longitudinal Data with Random Effects and AR(1) Errors" Journal of the American Statistical Association, 84, 452-459.

Keramidas, E. M. and Lee, J. C. (1990), "Forecasting Technological Substitutions with Concurrent Short Time Series", Journal of the American Statistical Association, 85, 625-632.

Lu, C. J. and Meeker, W. Q. (1993), "Using Degradation Measures to Estimate a Time-to-Failure Distribution", Technometrics, 35, 161-174.

Lee, J. C. and Geisser, S. (1975), "Applications of Growth Curve Prediction", Sankyha, Series. A, 37, 239-256.

Lee, J. C. (1991), "Test and Model Selection for the General Growth Curve Model", Biometrics, 47, 147-159.

Ostergaard, D. F. and Hillberry, B. M. (1983), "Characterization of he Variability in Fatigue Crack Propagation Data; " in Probabilistic Fracture Mechanics and Fatigue Methods: Applications for Structural Design and Maintenance, ASTM STP 798, eds. J. M. Bloom and J. C. Ekvall, Philadelphia: American Society for Testing and Materials, pp 97-115.

Rao, C.R. (1987), "Prediction of Future Observations in Growth Curve models", Statistical Science, 2, 434-471

Trantina, F. F. and Johnson, C. A. (1983), "Probabilistic Defect Size Analysis Using Fatigue and Cyclic Crack Growth Rate Data, " in Probabilistic Fracture Mechanics and Fatigue Methods: Applications for Structural Design and Maintenance, ASTM STP 798, eds. J. M. Bloom and J. C. Ekvall, Philadelphia, American Society for Testing and Materials, pp 67-78