

Abstract of Workshop 2015 -Advances in DEA Theory and Applications with Extensions to Forecasting Models

Date December 1st-2nd, 2015

Venue: Conference Room 4A, National Graduate Institute for Policy Studies (GRIPS)

Workshop Organizer: **Prof. Kaoru Tone**, GRIPS

December 1st, 13:25-17:00

13:25-13:30 Opening Remarks: Prof. Kaoru Tone (GRIPS, Japan)

13:30-15:00 Session 1. Chair: Prof. Joseph Paradi (Univ. of Toronto, Canada)

1. "Resampling in Data Envelopment Analysis illustrated by a hospital example"

Author: Kaoru Tone (GRIPS, Japan)

Abstract: In this paper, we propose new resampling models in data envelopment analysis (DEA). Input/output values are subject to change for several reasons, e.g., measurement errors, hysteretic factors, arbitrariness and so on. Furthermore, these variations differ in their input/output items and their decision-making units (DMU). Hence, DEA efficiency scores need to be examined by considering these factors. Resampling based on these variations is necessary for gauging the confidence interval of DEA scores. We propose two resampling models. The first model utilizes historical data, e.g., past-present, for estimating data variations, imposing chronological order weights which are supplied by Lucas series (a variant of Fibonacci series). The second one deals with future prospects. This model aims at forecasting the future efficiency score and its confidence interval for each DMU. We applied our models to dataset composed of Japanese municipal hospitals.

Keywords: Data variation; resampling; confidence interval; past-present-future DEA; hospital

2. "Combining Support Vector Machine and Data Envelopment Analysis to Predict Corporate Failure for Nonmanufacturing Firms".

Corresponding author: Xiaopeng Yang (Univ. of Toronto, Canada)

Co-author: Stanko Dimitrov (Univ. of Waterloo, Canada)

Abstract: Research on corporate failure prediction has drawn numerous scholars' attention because of its usefulness in corporate risk management, as well as in regulating corporate operational status. Most previous research related to this topic focused on manufacturing companies and relied heavily on corporate assets. The asset size of a manufacturing company plays a vital role in traditional research methods; Altman's Z score model is one such traditional method. However, very limited number of research studied corporate failure prediction for nonmanufacturing companies as the operational status of such companies is not solely correlated to their assets. In this manuscript we use support vector machines (SVMs) and data envelopment analysis (DEA) to provide a new method for predicting corporate failure of nonmanufacturing firms. We first generate efficiency scores using a slack-based measure (SBM) DEA model, using the recent three

years historical data of nonmanufacturing firms; then we used SVMs to classify bankrupt firms and healthy ones. We show that using DEA scores as the only inputs into SVMs predict corporate failure more accurately than using the entire raw data available.

Keyword: support vector machine (SVM); data envelopment analysis (DEA); corporate failure; nonmanufacturing firms; predictions.

3. "Data Envelopment Analysis of Corporate Failure for Non-Manufacturing Firms Using a Slacks-Based Measure"

Corresponding author: Joseph Paradi (Univ. of Toronto, Canada)

Co-author: D'Andre Wilson, Xiaopeng Yang (Univ. of Toronto, Canada)

Abstract: The problem of predicting corporate failure has intrigued many in the investment sector, corporate decision makers, business partners and many others, hence the intense research efforts by industry and academia. The majority of former research efforts on this topic focused on manufacturing companies with considerable assets commensurate with their size. But there is a dearth of publications on predicting non-manufacturing firms' financial difficulties since these firms typically do not have significant assets or, indeed, any need for them as their work does not rely heavily on assets as a key variable. Our research shows that the slack-based measure (SBM) DEA model has obvious advantages in predicting corporate financial stress.

Keyword: corporate failure; non-manufacturing company; predictions; data envelopment analysis (DEA); Altman's Z score.

15:00-15:30 Coffee Break

15:30-17:00 Session 2. Chair: Prof. Hirofumi Fukuyama (Fukuoka Univ., Japan)

4. "Dynamic-Network DEA and An application to Japanese Hospitals"

Corresponding author: Hiroyuki Kawaguchi (Seijo Univ., Japan),

Co-authors: Kaoru Tone (GRIPS, Japan), Miki Tsutsui (CRIEPI, Japan)

Abstract: The purpose of this study was to perform an evaluation of the policy effect of the current reform of Japan's municipal hospitals. We focused on efficiency improvements both within hospitals and within two separate internal hospital organizations. Hospitals have two heterogeneous internal organizations: the medical examination division and administration division. We extend observation time from 3years to 6years to compare to previous version of this study. We also added new variable MRI as link variable.

Results showed that the average overall efficiency obtained with the DN-DEA model was 0.829 for 2007. The change in efficiency scores from 2007 to 2012 was slightly lower. The average estimated efficiency of both the administration division and medical-examination division decreased. We were unable to find any significant improvement in efficiency despite the reform policy. Thus, there are no positive policy effects despite the increased financial support from the central government.

Keyword: DN-DEA model, Japanese hospital, municipal, Malmquist index, MRI.

5. "DEA and social policy: A performance evaluation of Japanese local welfare offices".

Author: Masayoshi Hayashi (Univ. of Tokyo, Japan)

Abstract: We examine the efficiency of social welfare offices in Japan and explore the external factors that affect their efficiency. We elaborate on the influence of population, surface area, and fiscal capacity and present preliminary scores that allow for their effects.

Keyword: Social welfare office, public assistance, DEA, Japan

6. “A dynamic-network slacks-based measure with an application to Japanese Prefectures”

Corresponding author: Hirofumi Fukuyama (Fukuoka Univ., Japan)

Co-authors: Hashimoto (Fukuoka Girls’ Commercial High School), Kaoru Tone (GRIPS, Japan), William Weber (Southeast Missouri State University, USA)

Abstract: This paper develops a dynamic-network DEA (data envelopment analysis) model where total output is jointly produced from two sectors: a human capital sector and a physical capital sector. While human capital is treated as an exogenous input, physical capital production is an intermediate output of one period that becomes an input to a subsequent period. The method is applied using pooled data on 47 Japanese prefectures during the period 2007-2009.

Keyword: Dynamic DEA, network DEA, dynamic-network model

December 2nd, 10:00-16:00

10:00-11:30 Session 3. Chair: Prof. Jamal Ouenniche (Univ. of Edinburgh, UK)

7. DEA Models Involving Future Performance”

Corresponding author: Tsung-Sheng Chang (National Chiao Tung Univ., Taiwan)

Co-authors: Kaoru Tone (GRIPS, Japan), Chen-Hui Wu (National Chung Cheng University, Taiwan)

Abstract: In many practical applications, past results are not sufficient for evaluating a DMU’s performance in highly volatile operating environments, such as those with highly volatile crude oil prices and currency exchange rates. That is, in such environments, a DMU’s whole performance may be seriously distorted if its future performance, which is sensitive to crude oil price volatility and/or currency fluctuations, is ignored in the evaluation process. Hence, this research aims at developing a new system of DEA models that incorporate a DMU’s uncertain future performance, and thus can be applied to fully measure their efficiency.

Keyword: Data envelopment analysis, Performance evaluation, Forecast, Dynamic, Entropy.

8. “Performance evaluation of prediction models under multiple criteria”

Corresponding author: Bing Xu (Heriot-Watt Univ., UK)

Co-authors: Jamal Ouenniche (Univ. of Edinburgh, UK), Kaoru Tone (GRIPS, Japan)

Abstract: With the increasing number of quantitative models available to forecast the crude oil prices and its volatility, the assessment of the relative performance of competing models becomes a critical task. So far, competing forecasting models are compared to each other using a single criterion at a time, which often leads to different rankings for different criteria – a situation where one cannot make an informed decision as to which model performs best when taking all criteria into account. In order to overcome this

methodological problem, we proposed a multidimensional framework based on Data Envelopment Analysis models to rank order competing forecasting models.

Keyword: Forecasting crude oil prices' volatility, performance evaluation, data envelopment analysis (DEA), commodity and energy markets.

9. "An Out-of-Sample Evaluation Framework for DEA with Application in Bankruptcy Prediction"

Corresponding Author: Jamal Ouenniche (Univ. of Edinburgh, UK)

Co-author: Kaoru Tone (GRIPS, Japan)

Abstract: Nowadays, Data Envelopment Analysis (DEA) is a well-established non-parametric methodology for performance evaluation and benchmarking. DEA has witnessed a widespread use in many application areas since the publication of the seminal paper by Charnes, Cooper and Rhodes in 1978. However, to the best of our knowledge, no published work formally addressed out-of-sample evaluation in DEA. In this paper, we fill this gap by proposing a framework for the out-of-sample evaluation of decision making units. We illustrate the use of the proposed framework in risk assessment and bankruptcy prediction of companies listed on the London Stock Exchange.

Keyword: Data Envelopment Analysis, Out-of-Sample Evaluation, Case-based Reasoning, k-Nearest Neighbor, Bankruptcy Prediction, Risk Assessment

11:30-13:00 Lunch

13:00-14:00 Session 4. Chair: Prof. Andrew Johnson (Texas A&M Univ., USA)

10. "A quantitative analysis of market opportunity utilization in electric power companies"

Corresponding author: Miki Tsutsui (CRIEPI, Japan)

Co-author: Kaoru Tone (GRIPS, Japan)

Abstract: In EU countries and several states in the U.S., the wholesale power markets are well developed enough to be utilized by many electric power companies. These companies usually have a trading division which intensively handles all of transactions with fuel and power markets standing between generation and retail divisions, even if they were vertically integrated before liberalization. This study quantitatively evaluates the effects of potential use of market opportunities through the trading division, and compare them under different conditions and constraints. Then we clarify the problem that under which price conditions in the future the trading function will work effectively.

Keyword: electric power market, trading mechanism, internal transaction, profit maximization, SBM-max model

11. "Predictive Efficiency Analysis: A study of U.S. Hospitals"

Corresponding author: Andrew Johnson (Texas A&M Univ., USA)

Co-author: Chia-Yen Lee (National Cheng Kung University, Taiwan)

Abstract: Healthcare costs are higher in the U.S. than anywhere else in the world. A significant portion of the costs are generated in hospitals. We investigate both the efficiency and the effectiveness of U.S. community hospitals using the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project 2009-2011 Nationwide Inpatient Sample, a data set which contains all discharges from an approximate 20% sample of hospitals. Here efficiency is the productivity of the hospital

measured relative to the most productive hospitals and effectiveness is how closely the hospital produced relative to the forecasted services needed. We find the effectiveness levels are slightly higher than the efficiency levels in both 2010 and 2011 indicating that hospitals are producing closer to the forecasted level than the actual service level needed. Further, both efficiency and effectiveness levels are low indicating a large variability in the level of resources hospitals use to provide the same set of services. The low effectiveness scores indicate that many hospitals have a high level of resources even relative to the forecasted demand providing some evidence for a medical arms race.

Keyword: Proactive DEA; Multiple output cost function; Performance Measurement

14:00-14:30 Coffee Break

14:30-15:30 Session 5. Chair: Prof. Ming-Miin Yu (National Taiwan Ocean Univ., Taiwan)

12. “Efficiency Predictions by Fuzzy Piecewise Auto-regression in Dynamic Network System”

Corresponding author: Bo Hsiao (Chang Jung Christian Univ., Taiwan)

Co-author: Ming-Miin Yu (National Taiwan Ocean Univ., Taiwan), Li-Hsueh Chen (National Taiwan Ocean Univ., Taiwan)

Abstract: Since efficiency prediction can help managers to monitor future performance and detect potential failures, it is important for production and operation management. Data envelopment analysis is comprehensively applied to evaluate the relative performance in various areas. However, only few studies try to forecast the relative performance estimated by data envelopment analysis. We propose a performance forecasting model that integrates the multi-activity dynamic network data envelopment analysis and fuzzy piecewise auto-regression. The proposed approach constructs a dynamic performance measurement with the network structure to calculate the catching-up efficiency index. The catching-up efficiency index is further decomposed into the technical efficiency change and dynamic efficiency change to capture the effect of carry-over items. The fuzzy piecewise auto-regression is applied to regress the possibility and necessity estimation models by catching-up efficiency index for forecasting efficiency. In this paper, a data from banks in Taiwan from 2006 to 2012 are applied. The results indicate that the proposed approach has highly accuracy rate.

Keyword: Multi-activity dynamic network Data envelopment analysis, fuzzy piecewise auto-regression, catching-up efficiency index, banking performance

13. “Prediction and performance evaluation of BDI forecasting models: Cross efficiency, the directional distance function and the AVS utility function”

Corresponding author: Ming-Miin Yu (National Taiwan Ocean Univ., Taiwan)

Co-author: Emrah Bulut (Yıldız Technical University, Turkey)

Abstract: In the study, we propose a nonparametric efficiency measurement approach for the forecasting model selection problem. Three autoregressive models and three fuzzy time series approaches are employed for the calibration of data structure to depict the trend. The directional distance function and portfolio theory are further used to evaluate the performance of BDI predictions. A directional distance function is defined that looks

for possible increases in accuracy and skewness, and decreases in variance obtained by cross efficiencies of those forecasting models. We also establish a link to proper indirect accuracy- variance -skewness (AVS) utility function for various users in various utilities. An empirical section on a set of forecasting Baltic Dry Index (BDI) forecasting models serves as an illustration.

Keyword: Baltic dry index; portfolio theory; cross efficiency; the directional distance function.

15:30- Closing Remarks: Prof. Hirofumi Fukuyama (Fukuoka Univ., Japan)