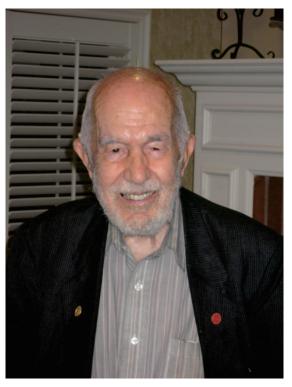Proceedings of Workshop 2013 on

Dynamic and Network DEA

Dedicated to the Memory of Professor W. W. Cooper

Bill Cooper 2009/10/15 (*photo by* Tone)

January 29-30, 2013

National Graduate Institute for Policy Studies

Contents

Preface

As our OR/MS community knows, Professor William W. Cooper passed away on June 20, 2012 at the age 97. We lost a great brain. I cannot help but say how I miss Bill. Let allow me to express some personal reminiscence.

I met Bill for the first time in 1986 at Dr. Charnes' office in Austin, Texas. In 1993, Bill visited Aoyama-Gakuin in Tokyo where we agreed to write a textbook on DEA. I began to write the first draft in 1996 and the book *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software* was published in late 1999 from Kluwer (now Springer) under co-authorship Cooper-Seiford-Tone. I will talk about something that happened during this publication. We exchanged a memorandum on writing this book. First, we agreed it should be a textbook but not a monograph. At that time we had no Windows and convenient e-mail system. So, I wrote the first draft in TEX and sent the DVI file as printed matter to Bill by airmail. It took about a week to reach Austin. Bill carefully read my draft and responded to me by revising it with his handwritten materials. It was a wonderful experience for me that, even if I wrote only a few lines on some subject, he expanded it to several pages! His sentences were long with no periods but with much ornamentation. When I was an undergraduate student, I read Immanuel Kant's Prolegomena zu einer jeden künftigen Metaphysik, die als Wissenschaft wird auftreten können, in the Reclam book. I wondered how the great philosopher expressed his thoughts through continuous long sentences in a multi-stratified manner. I felt the same surprise in Bill's writing. I first leant to write such long sentences just like composing a symphony. Bill's brain had a full of polyphonic structure. Moreover, his handwritten letters were difficult to decipher, as many acquaintances know. He said that when he was a schoolboy he was awarded in penmanship. However, after the invention of the ballpoint pen, he came to write speedily to express his flowing ideas one after another. So, his cacography is caused by the ballpoint pen! See Figure A.

I visited Bill on October 15, 2009. At that time Andy Johnson guided me to his beautiful retirement home in Austin. Last time I met him was November 9-10, 2010 when INFORMS Annual Conference was held at University of Texas, Austin, and a session was devoted in Honor of Bill Cooper.

We have had e-mail exchanges until May 7, 2012. We were expected to edit a special issue on DEA in some Internet Journal which, at the last moment, found to charge $600 for submission. Bill (with Larry Seiford and me) strongly took a stand against such system and the project was over.

No words can express the deep sorrow I felt when I heard of his demise on June 20, 2012. I would like to dedicate this workshop to his memory.

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8.8 Summary ~~on~~ and Conclusion

This chapter has covered the approaches which have been standard in DEA evaluations of efficiency such as "allocative" and "overall" efficiencies. These standard approaches were also extended ~~to permit~~ in models that permit substitution so that ~~worsening~~ worsening of some inputs or outputs may be made in order to improve other inputs or outputs

Such inefficiencies are price-cost related. This can cause problems in the use of these concepts since many companies are unwilling to disclose their unit costs. Unit prices may also be a problem when these values are subject to large fluctuations. One may, of course, use averages or other summaries of such prices and also deduce or infer what

Figure A: A copy of Bill's manuscript in Chapter 8 of DEA book from Kluwer AP

This volume includes nine papers presented for the workshop at GRIPS, Japan, January 29-30, 2013, which are summarized as follows (in the order of presentation). Worldwide Web Conference System is available so that interested researchers can join the workshop from over the world.

January 29, 14:00-17:30
Session 1. Session Chair: Hirofumi Fukuyama (Fukuoka University)

1. "Dynamic DEA with network structure -A slacks-based measure approach-"
   Authors: Kaoru Tone (National Graduate Institute for Policy Studies, Japan) and Miki Tsutsui (Central Research Institute of Electric Power Industry, Japan)

   Abstract: In this paper we develop a dynamic DEA model with network structure (DNSBM) as a composition of the dynamic SBM (DSBM) and the network SBM (NSBM). Furthermore, we propose the divisional and overall dynamic Malmquist indices by which we can identify divisional differences in productivity growth along with overall productivity change. As a numerical example, we apply DNSBM to a dataset of electric power companies. We compare DNSBM with DSBM and demonstrate that the DNSBM model can reveal the efficiency status more accurately than the DSBM, because the DNSBM model includes the internal network structure of DMUs.

2. "Dynamic network Malmquist model based on green input-output table"
   Corresponding author: Ming Lei (Guanghua School of Management, Peking University, China), *Co-authors*: Kaoru Tone (GRIPS) and Xinna Zhao (Peking University)

   Abstract: For revealing the influence of intermediate transactions between industrial sectors to the dynamic performance, this paper develops a framework of dynamic performance with network structure measurement by establishing a dynamic network Malmquist productivity index (DNMPI) model following the dynamic network slacks-based measure (DNSBM) model. In order to explore the performance, we decompose the model to identify the dynamic efficiency (inter-temporal influence) and the network efficiency (sector interaction) based on green accounting. Furthermore, this paper analyzes Chinese dynamic performance with network structure influenced by energy-economy-environment (3E) in the view of industrial chain effect. We apply it to analyze the data of 40 industrial sectors in China from 2002, 2005 and 2007. Based on empirical results, we systematically indicate the influence of energy efficiency and environment efficiency to the economic development in China.

3. "Dynamic network *range-adjusted* measure vs. dynamic network *slacks-based* measure"
   Corresponding author: Necmi Kemal Avkiran (UQ Business School, The University of Queensland, Australia), *Co-author*: Alan McCrystal (University of Queensland)

   Abstract: We formulate weighted, dynamic network range-adjusted measure (D-NRAM) and dynamic network slacks-based measure (D-NSBM), run robustness tests and compare results. To the best of our knowledge, the current paper is the first to compare two weighted dynamic network DEA models and it also represents the first attempt at formulating D-NRAM. We illustrate our models using simulated data on *residential aged care*. Insight gained by running D-NRAM in parallel with D-NSBM includes (a) identical benchmark groups, (b) a substantially wider range of efficiency estimates under D-NRAM, and (c) evidence of inefficient DMU size bias. D-NRAM is also shown to have the additional desirable technical efficiency properties of translation-invariance and acceptance of data. Managerial implications are also briefly discussed.

4. "Dynamic evaluation of batters in Nippon professional baseball leagues
   -A new proposition relating to multiplier bounds in DEA-AR-"
   Corresponding author: Tohru Ueda (Seikei University)

   Abstract: In each of Nippon Professional Baseball Leagues (NPBL), only about twenty batters over 220 times at bat played during years 2008-2012. Therefore in evaluation of batters, we cannot use long time series data for the same batter. At first possibility of efficiency evaluation based on short past data is discussed. In the next place evaluations of batters based on batting orders is discussed. In such DEA models as CCR, multipliers which may cause bad effects for evaluation may be neglected, that is, the values of the corresponding multipliers may become 0. To improve this shortcoming, the assurance region methods, which have bounds relating to multipliers were proposed. We propose new methods based on the absolute deviation, by which the bounds are derived effortlessly from limited information, i.e., partial ranking data. The methods are applied to the evaluation of baseball players in NPBL

January 30, 10:00-16:10
Session 2. Session Chair: Necmi K Avkiran (The University of Queensland)

5. "Dynamic network DEA and an application to Japanese prefectures"
   Corresponding authors: Hirofumi Fukuyama (Fukuoka University, Japan) and Atsuo Hashimoto (Fukuoka University), *Co-author*: Kaoru Tone (GRIPS)

   Abstract: The purpose of this paper is twofold. First, we develop a multi-period dynamic multi-process network DEA (data envelopment analysis) model. Second, we apply this methodology to Japanese prefectural time series data. In this framework, we specify that prefectural technology consists of two sectors, called the human capital generating sector and

the physical capital formation sector. Each sector has its own exogenous inputs, and carry-overs in preceding and subsequent periods as well as final output.   We assume that the final output is produced jointly by the two sectors.

6. "US hospital performance: A dynamic network analysis"

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

Co-authors: Brandon Pope (Purdue University, USA) and Kaoru Tone (GRIPS)

Abstract: Healthcare is a critical and costly industry. In the U.S. a significant component of healthcare costs are expenses generated in hospitals. This paper reports the results of analyzing 607 U.S. hospitals between 2006-2009 using a dynamic network slack-based Data Envelopment Analysis (DEA) Model. We find accounting for the dynamic and network structure of the hospital lowers efficiency estimates. Further, hospitals are more efficient at providing hospital services compared to hotel services, but the efficiency of hospitals is not correlated with their size. Regarding the dynamic network slack-based DEA Model, we find slack-based approaches combine technical and allocative aspects of inefficiency and thus tend to have significantly lower efficiency levels than just radial technical efficiency measures. Further when applying an envelopment method like DEA, there are some benefits to averaging multiple years of data to remove variation and avoid estimating a frontier based on observations that might have significant noise in their measurement.

7. "Technical efficiency accounting for environmental influence in the Japanese gas market"

Author: Sumiko Asai (School of Social Information Studies, Otsuma Women's University, Japan)

Abstract: This study measured technical efficiency accounting for environmental influence in the Japanese gas market by stochastic frontier analysis (SFA) and data envelopment analysis (DEA). The results showed that from the viewpoint of fitness, the stochastic frontier production function incorporating an external factor was more appropriate than one without it. The study also found that the distribution of efficiency scores calculated by the DEA model incorporating an external factor was more similar to that by the SFA model incorporating the factor, compared to that by the DEA model without incorporating it. These findings imply that considering the impact of external conditions on technical efficiency is essential for the Japanese gas market.

Session 3. Session Chair: Andrew L. Johnson (Texas A&M University)

8. "Estimation of the efficiency of Japanese hospitals using a dynamic and network data envelopment analysis model"

Corresponding author: Hiroyuki Kawaguchi (Economics Faculty, Seijo University, Tokyo, Japan), *Co-authors*: Kaoru Tone (GRIPS) and Miki Tsutsui (CRIEPI)

Abstract: This study evaluates the policy effect of the reformation of municipal hospitals in Japan. We focused on the efficiency improvement of not only the hospital itself but also separate internal organizations of a hospital. Hospitals have two heterogeneous internal organizations: the medical-examination section and administration section. The administration section carries out business management and the medical-examination section provides medical care services. We employed a dynamic and network data envelopment analysis model. The model makes it possible to estimate both the efficiencies of separate organizations and the dynamic changes of the efficiencies simultaneously. We found that there are positive policy effects. Additionally, we should focus on the administration section rather than the medical-examination section in reforming municipal hospitals in Japan.

9. "Operational efficiency in Taiwan banks with consideration of nonperforming loans: A dynamic network DEA"

Corresponding author: Ming-Miin Yu (National Taiwan Ocean University, Taiwan), *Co-authors*: Li-Hsueh Chen (National Taiwan Ocean University), Kuan-Chen Chen (Taipei Medical University) and Kaoru Tone (GRIPS)

Abstract: This paper applies a slacks-based measure dynamic data envelopment analysis (SBM-DNDEA) model to simultaneously evaluate overall, deposit, lending, period, deposit-period and lending-period efficiencies for 22 Taiwanese banks over the period from 1999 to 2011. We treat deposit as the intermediate output flowing from the deposit process to the lending process, and use non-performing loan as undesirable output capturing the effect of carry-over activity. The results indicate that the improvement in individual process has positive effect on banks' performance, while efficiency in the deposit process may not guarantee efficiency in the lending process, and vice versa. The period efficiency for all banks has the stable variance over the sample period. Besides, the efficiencies based on operational characteristics are further compared.

Workshop Organizer
Kaoru Tone
GRIPS