Performance Evaluations and the Technology Gap Ratio in WBC Baseball Teams

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Abstract. The aim of this study is to extend performance modeling in sports. The importance of efficiency in team sports is well supported in the literature. This study evaluates the performance of national teams for the 2006 and 2009 World Baseball Classic events and applies the concepts of the metafrontier and the technology gap ratio.

Keywords: Efficiency, Productivity, Metafrontier, Offense, Defense

1. Introduction

The concepts of efficiency and productivity have been applied extensively in sports [1], including studies of basketball [2], football [3, 4, 5], professional golf [6], and even the Olympic games [7, 8, 9, 10, 11]. In baseball, [1] efficiency is relatively more important in areas in which labor is inexpensive, especially in performance evaluations of baseball teams and players. Anderson et al. [12] and Sueyoshi et al. [13] use data envelopment analysis (DEA) to measure the efficiency of individual baseball players. Sexton et al. [14] and Lewis et al. [1, 15, 16] extend the network DEA methodology to measure the efficiency of Major League Baseball (MLB) teams.

Battese et al. [17] use the DEA approach to construct a metafrontier that pools all observations from all regions and to develop various regional frontiers to analyze efficiency and the technology gap ratio (TGR). The metafrontier framework evaluates the efficiency of each decision-making unit (DMU) with respect to its group frontier. The DMUs in each group are assumed to have the same characteristics (e.g., they use the same type of contract). To compare efficiency across groups, a metafrontier is developed using the best practices of all groups. The estimation of the gap between each group's frontier and the metafrontier can help decision makers identify performance improvement strategies [18].

The World Baseball Classic (WBC), which was created to promote the game worldwide, pioneered the use of national baseball teams featuring professional players from international major leagues, including the MLB. This international baseball tournament has been created by the MLB and other professional baseball leagues and players' associations and is approved by the International Baseball Federation (IBAF). The WBC and the Baseball World Cup are the two active tournaments considered by the IBAF to be major world championships.

The aim of this study is to extend performance modeling in sports. The importance of efficiency in team sports is well supported in the literature. This study evaluates the performance of national teams for the 2006 and 2009 World Baseball Classic events and applies the concepts of the metafrontier and the TGR.

2. Performance evaluation and the technology gap ratio

2.1. Baseball teams' performance evaluation

This study draws upon previous studies [1, 14, 15, 16] and extends the network DEA model to measure baseball teams' offense, defense, and integration efficiency for the 2006 and 2009 World Baseball Classic events. Lewis et al. [1] considered the offensive efficiency consumes offensive contributions as total bases gained (TBG), walks gained, and errors gained (committed by the team's opponents) to produce runs gained;

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the defensive efficiency consumes defensive contributions as total bases surrendered, walks surrendered, and errors surrendered to prevent runs surrendered; and the integration efficiency consumes runs gained and runs surrendered to produce games won (Fig. 1). As note that total bases surrendered (TBS), walks surrendered, errors surrendered, and runs surrendered are reverse quantities. For offense, TBG is equal to singles+ doubles+ triples+ homeruns. For defense, TBS is equal to total bases+ walks+ errors.

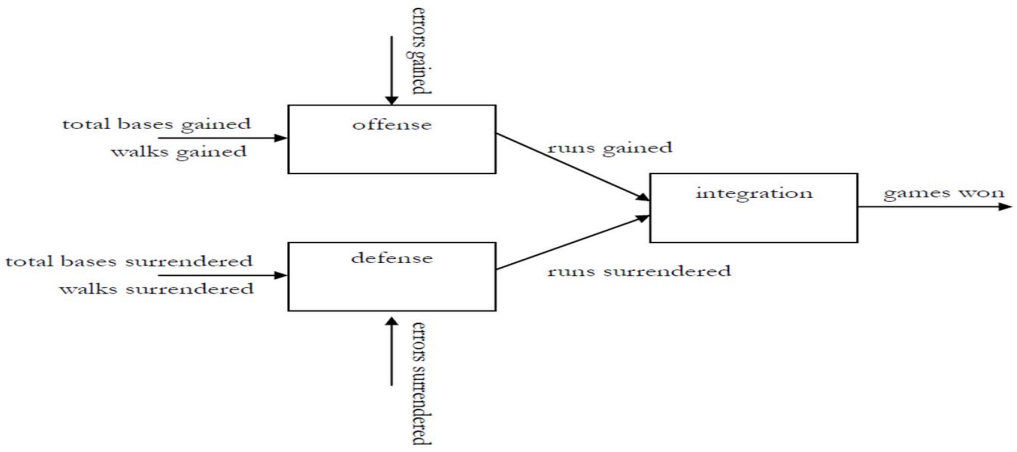

Fig. 1 Baseball teams' performance evaluation model (Lewis and Sexton, 2004a)

2.2. Metafrontier

Fig. 2 presents a simple graphical illustration of the metafrontier with one input and one output variable. The DMUs under analysis belong to two heterogeneous groups; therefore, two group frontiers are computed, represented by XX' and YY'. Consider a specific DMU operating at the input-output combination labeled A. The output-oriented technical efficiency of DMU A with respect to its group frontier XX' and meta-frontier MM' are calculated as follows:

$$TE_{XX'}(A)=\frac{OB}{OC}, TE_{MM'}(A)=\frac{OB}{OD}. \tag{1}$$

To analyze the gap between the group frontier XX' and the meta-frontier MM', the technology gap ratio (TGR) of DMU A is defined as follows:

$$TGR_{XX'}(A)=\frac{TE_{MM'}(A)}{TE_{XX'}(A)}=\frac{OB/OD}{OD/OC}=\frac{OC}{OD}. \tag{2}$$

The TGR measures how close a group frontier is to the meta-frontier. Eq. (3), as a reconstruction of Eq. (2), implies that the technical efficiency of DMU A measured with respect to the metafrontier can be decomposed into the product of technical efficiency with respect to the group frontier (representing the characteristics of the group and its state of knowledge) and the meta-technology ratio for group XX' (representing how close the group frontier is to the metafrontier) [18].

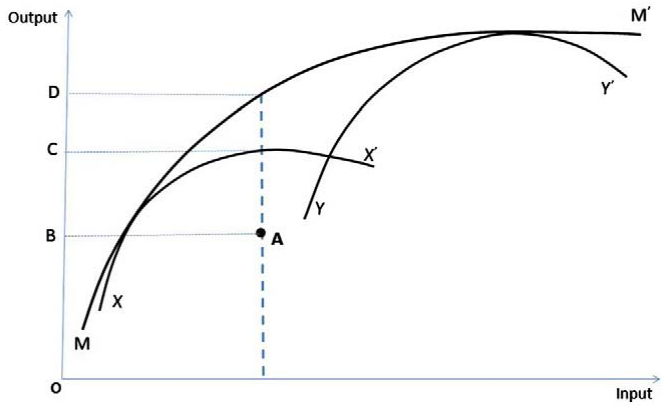

Fig. 2 The graphic for meta-frontier and group frontiers (O' Donnell, et al., 2008)

$$TE_{MM'}(A) = TE_{XX'}(A) * TGR_{XX'}(A). \quad (3)$$

Assuming that $TE_{MM'}$ is 0.4 and $TE_{XX'}$ is 0.6, the TGR would be 0.667. Given the input vector (cost), the maximum output that can be produced by group-MM' is 66.7% of the output that is feasible when using the metafrontier as a benchmark. Thus, an increase in the TGR implies a decrease in the gap between the group frontier and the metafrontier.

2.3. Results

The model calculates the efficiency performance of 32 teams for the 2006 and 2009 WBC events [15]. Most of the teams promoted to the second round outperformed the teams stopped in the first round in technical efficiency. Table 1 presents the teams' average efficiencies. In 2006, Korea, Cuba, and Canada were relatively efficient in offense, defense, and integration. In 2009, Japan, the Netherlands, Venezuela, the United States, Mexico, and China were relatively efficient with regard to the countries' own frontiers.

Table 1. Teams' efficiency over the period 2006 and 2009 WBC events

no		2006	2009
1	Dominican Republic	0.988	0.444
2	Japan	0.908	1.000
3	Puerto Rico	0.697	0.865
4	Korea	1.000	0.974
5	Netherlands	0.274	1.000
6	Cuba	1.000	0.787
7	Venezuela	0.706	1.000
8	Canada	1.000	0.000
9	United States	0.551	1.000
10	Italy	0.284	0.667
11	Panama	0.000	-
12	Chinese Taipei	0.274	-
13	Australia	-	0.362
14	Mexico	0.585	1.000
15	China	-	1.000
16	South Africa	-	-

Eight inefficient teams are initially eliminated from the WBC because rounds one and two of the tournament are conducted in a double-elimination format. Thus, an increase in the teams' TGR implies a decrease in the gap between the eliminated teams' frontiers and the metafrontier. In 2006, Italy and the Netherlands produced the best TGR, and in 2009, China was close to the metafrontier. Less efficient teams with high TGRs (Chinese Taipei and Canada in 2006, the Dominican Republic and Australia in 2009) should focus on output augmentation strategies to increase the runs gained and adjust the runs surrendered to reduce the technology gap.

Table 2. The technological gap ratio of eliminated teams in round one

no		2006 TGR	2009 TGR
1	Dominican Republic	-	2.252
2	Netherlands	0.729	-
3	Canada	1.000	-
4	Italy	0.002	1.499
5	Chinese Taipei	1.825	-
6	Australia	-	2.762
7	China	-	1.000

2.4. Conclusion

This study used a network DEA model and metafrontier to evaluate the efficiency of national teams for the 2006 and 2009 World Baseball Classic and to compare the teams' efficiency with respect to a common frontier model. The results show that teams promoted to the second round in the WBC outperform teams eliminated in the first round in technical efficiency. However, the TGR provides significant information for teams eliminated in the first round, reducing the technology gap. Whether the number of runs gained is

increased or the number of runs surrendered is adjusted, the gap between teams is attributed primarily to the level and the composition of the output rather than the input.

3. Acknowledgements

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4. References

[1] H. F. Lewis, K. Lock, and T. R. Sexton. Organizational capability, efficiency, and effectiveness in Major League Baseball: 1901-2002. *European Journal of Operational Research*. 2009, 197: 731-740.

[2] W. W. Cooper, J. L. Ruiz, and I. Sirvent. Selecting non-zero weights to evaluate effectiveness of basketball players with DEA. *European Journal of Operational Research*. 2009, 195: 563-574.

[3] D. J. Haas*. Technical efficiency in the major league soccer. *Journal of Sports Economics*. 2003, **4**(3): 203-215.

[4] F. González-Gómez, and A. J. Picazo-Tadeo. Can we be satisfied with our football team? evidence from Spanish professional football. *Journal of Sports Economics*. 2010, **11**(4): 418-442.

[5] C. P. Barros, A. Assaf, and F. Sá-Earp. Brazilian football league technical efficiency: a Simar and Wilson approach. *Journal of Sports Economics*. 2010, **11**(6): 641-651.

[6] H. O. Fried, J. Lambrinos, and J. Tyner. Evaluating the performance of professional golfers on the PGA, LPGA, and SPGA tours. *European Journal of Operational Research*. 2004, 154: 548-561.

[7] S. Lozano, G. Villa, F. Guerrero, and P. Cortés. Measuring the performance of nations at Summer Olympics using data envelopment analysis. *Journal of Operational Research Society*. **53**(5): 501-511.

[8] M. P. E. Lins, E. G. Gomes, J. C. C. B. Soares de Mello, and A. J. R. Soares de Mello. Olympic ranking based on a zero sum gains DEA model. *European Journal of Operational Research*. 2003, 148: 312-322.

[9] Y. J. Li, L. Liang, Y. Chen, and H. Morita. Models for measuring and benchmarking Olympics achievements. *Omega*. 2008, 36: 933-940.

[10] J. Wu, L. Liang, and Y. Chen. DEA game cross-efficiency approach to Olympic rankings. *Omega*. 2009, 37: 909-918.

[11] J. Wu, L. Liang, and F. Yang. Achievement and benchmarking of countries at the Summer Olympics using cross efficiency evaluation method. *European Journal of Operational Research*. 2009, 197: 722-730.

[12] T. R. Anderson, and G. P. Sharp. A new measure of baseball batters using DEA. *Annals of Operations Research*. 1997, 73: 141-155.

[13] T. Sueyoshi, K. Ohnishi, and Y. Kinase. A benchmark approach for baseball evaluation. *European Journal of Operational Research*. 1999, 115: 429-448.

[14] T. R. Sexton, and H. F. Lewis. Two stage DEA: an application to major league baseball. *Journal of Productivity Analysis*. 2003, 19: 227-249.

[15] H. F. Lewis, and T. R. Sexton. Network DEA: efficiency analysis of organizations with complex internal structure. *Computers & Operations Research*. 2004a. 31: 1365-1410.

[16] H. F. Lewis, and T. R. Sexton. Data envelopment analysis with reverse inputs and outputs. *Journal of Productivity Analysis*. 2004b, 21: 113-132.

[17] G. E. Battese, D. S. P. Rao, and C. J. O'Donnell. A metafrontier production function for estimation of technical efficiencies and technology gaps for firms operating under different technologies. *Journal of Productivity Analysis*. 2004, 21: 91-103.

[18] C. J. O'Donnell, D. S. Prasada Rao, and G. E. Battese. Metafrontier frameworks for the study of firm-level efficiencies and technology ratios. *Empirical Economics*, 2008, 34: 231-255.