



et al.'s [3] models with the aim of developing a pair of alternative approaches for selecting performance measures under variable returns-to-scale (VRS) assumption. Keshavarz and Toloo [7] proposed a single stage approach for selecting inputs/outputs in DEA, based on the VRS assumption and the common set of weights methodology. Toloo and Allahyar [8] extended an envelopment form of selecting the model of Toloo et al. [3].

The current paper attempts to compare two individual and aggregate of selecting models under CRS and VRS assumption, from the envelopment form point of view. The content of this paper is organized in the following way: Section 2 provides a review of the standard envelopment form models of DEA satisfying the CRS and VRS assumptions. In Sections 3, two individual-based selecting models under CRS and VRS assumptions are reviewed. A pair of aggregate models is formulated in Section 4 to select the adequate performance measures for CRS and VRS technologies. In order to show the applicability and compare the proposed models, in Section 5, a real data set of bank industry is used. Conclusions and future researchers are provided in the last section.

## 2. Standard DEA Models

The first two basic DEA models are originated by Charnes, Cooper and Rhodes in 1978 and Banker, Charnes and Cooper in 1984 and hence these models are known as the CCR and BCC models. The former model is formulated for CRS assumption meanwhile the latter model deals with VRS assumption. Assume that there are  $n$  DMUs and each DMU $_j$  ( $j = 1, \dots, n$ ) uses  $m$  semi-positive inputs  $\mathbf{x}_j = (x_{1j}, \dots, x_{mj})$  to produce  $s$  semi-positive outputs  $\mathbf{y}_j = (y_{1j}, \dots, y_{sj})$ . The following pair of models measures the CCR- and BCC-efficiency score of unit under evaluation, i.e. DMU $_o$ , respectively:

$$\begin{aligned} & \max \theta - \varepsilon (\sum_{i=1}^m s_i^x + \sum_{r=1}^s s_r^y) \\ & \text{s. t.} \\ & \sum_{j=1}^n \lambda_j x_{ij} + s_i^x = \theta x_{io} \quad \forall i \\ & \sum_{j=1}^n \lambda_j y_{rj} - s_r^y = y_{ro} \quad \forall r \\ & \lambda_j \geq 0, s_i^x \geq 0, s_r^y \geq 0 \quad \forall j, \forall i, \forall r \end{aligned} \tag{1}$$

$$\begin{aligned} & \max \theta - \varepsilon (\sum_{i=1}^m s_i^x + \sum_{r=1}^s s_r^y) \\ & \text{s. t.} \\ & \sum_{j=1}^n \lambda_j x_{ij} + s_i^x = \theta x_{io} \quad \forall i \\ & \sum_{j=1}^n \lambda_j y_{rj} - s_r^y = y_{ro} \quad \forall r \\ & \sum_{j=1}^n \lambda_j = 1 \\ & \lambda_j \geq 0, s_i^x \geq 0, s_r^y \geq 0 \quad \forall j, \forall i, \forall r \end{aligned} \tag{2}$$

where  $\lambda_j$  is the intensity variable,  $s_i^x$  and  $s_r^y$  are the  $i^{th}$  input and  $r^{th}$  output slacks, respectively,  $\varepsilon > 0$  is the non-Archimedean infinitesimal (for more details about the role of non-Archimedean infinitesimal in DEA models we refer the readers to [9]). These models differ from the convexity constraint  $\sum_{j=1}^n \lambda_j = 1$ . These envelopment form of CCR and BCC models seeks a (virtual) unit  $(\sum_{j=1}^n \lambda_j^* \mathbf{x}_j, \sum_{j=1}^n \lambda_j^* \mathbf{y}_j)$  where its minimum output level is  $\mathbf{y}_o$  in all components, from the constraint  $\sum_{j=1}^n \lambda_j^* y_{rj} \geq y_{ro}; r = 1, \dots, m$ , while reducing the input vector  $\mathbf{x}_o$  proportionally to a value as small as possible, from the constraint  $\sum_{j=1}^n \lambda_j^* x_{ij} \leq \theta^* x_{io}; i = 1, \dots, m$ . If the objective value of models (1) and (2) is equal to one, (or equivalently  $\theta_o^* = 1, \forall i s_i^{x*} = 0$  and  $\forall r s_r^{y*} = 0$ ), then DMU $_o$  is CCR- and BCC-efficient. Otherwise  $(\sum_{j=1}^n \lambda_j^* \mathbf{x}_j, \sum_{j=1}^n \lambda_j^* \mathbf{y}_j)$  outperforms  $(\theta^* \mathbf{x}_o, \mathbf{y}_o)$  which means the unit under evaluation is inefficient under either CRS or VRS assumptions. As inspection makes clear, CCR-efficiency score of each unit is less than or equal to its BCC-efficiency score [5]. However, these models might be useless if the number of performance measures and DMUs does not meet the rule of thumb. In the next two sections, we review a pair of individual- and aggregate-based approach in the envelopment forms under CRS and VRS assumption with the aim of dealing with selective measures.











