Brief introduction to DEA theory and its applications in determination of return to scale

Data Envelopment Analysis (DEA) was established in 1978 by A. Charnes and W. W. Cooper etc.. DEA is a relatively new "data-oriented" approach for evaluating the performances of a set of entities called Decision Making Units (DMUs), which convert multiple inputs into multiple outputs. DEA has been applied in evaluating the performances of many different kinds of entities engaged in many different kinds of activities in many different contexts. It has opened up possibilities for use in cases which have been resistant to other approaches because of the complex and often unknown nature of the relations between the multiple inputs and outputs involved in many of these activities, which are often reported in non-commeasurable units. DEA has also been used to supply new insights into activities and entities that have previously been evaluated by other methods.

Return to scale, which is one of the most important conceptions in production theory, describes the relationship between the changes of manufacturer's production scale and the induced changes of production yields. According to the changing multiple of production scale and yields, the return to scale could be generally divided into three types, namely, increasing return to scale, constant return to scale and decreasing return to scale. While further division about the decreasing return to scale is made, the states of "saturation" and "congestion" can be obtained.

In this presentation, we first make a brief introduction of DEA theory, methods and models. And then, based on DEA theory, especially with the application of "Intersection-form" production possibility set, we (I) make a discussion on returns to scale of the states of increasing, constant, decreasing, saturation and congestion, respectively, (II) consider the decision making units of the current state, and present the dynamic determination for return to scale of various types, from the aspects of the inputs being increasing or decreasing. (III)Furthermore, we present the necessary and sufficient conditions for determining the return to scale being increasing, constant, decreasing, saturation and congestion, where the return to scale corresponds to certain inputs and certain outputs when certain inputs being augmenting or reducing in the system with multiple inputs and multiple outputs.