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Efficiency dynamics and sustainability of the Indian IT-ITeS industry: An empirical investigation using DEA

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Abstract Efficiency considerations of the Indian IT-ITeS industry have come to the forefront especially with slowdown in the US and other major industrialised economies. Using the DEA technique, this paper argues that the key to sustainability rests on the operational efficiency of the players. Primary data for this study has been collected from STP Kolkata for a period of 15 years. The results reveal that (technical) efficiency varies across industry segments and increases with greater global orientation of the unit. The study prescribes segment-specific policies for sustainability of the industry instead of a uniform policy that has been the usual practice.

The Indian IT-ITeS industry has been successful in positioning itself as one of the most favoured outsourcing destinations, especially since the beginning of the 21st century. However, in recent times, issues concerning sustainability of the industry have come to the forefront. The outbreak of the sub-prime crisis that has engulfed major industrialised nations, notably the US (India's major trading partner) has resulted in lower offshore outsourcing. This is coupled with rising wage inflation that is eroding cost arbitrage; stiff competition from various low-cost destinations like Ireland, China, Philippines, and Vietnam that is eating into India's share in the offshore outsourcing pie; lack of product innovation leading to specialisation in services (and not products) and thereby lower earnings; and exchange rate vulnerabilities resulting in uncertain export realisations.

In view of these developments, efficiency considerations have assumed prominence, since sustainability of this industry rests on the operational efficiency of its players. As a result, identification of possible determinants of efficiency is of prime importance, both for industry participants and policymakers. However, this important aspect of efficiency considerations in the context of the Indian IT-ITeS industry has remained unexamined, primarily due to the paucity of granular data.

In this study, an attempt has been made to measure efficiency and thereby identify the possible determinants of efficiency, by incorporating Data Envelopment Analysis

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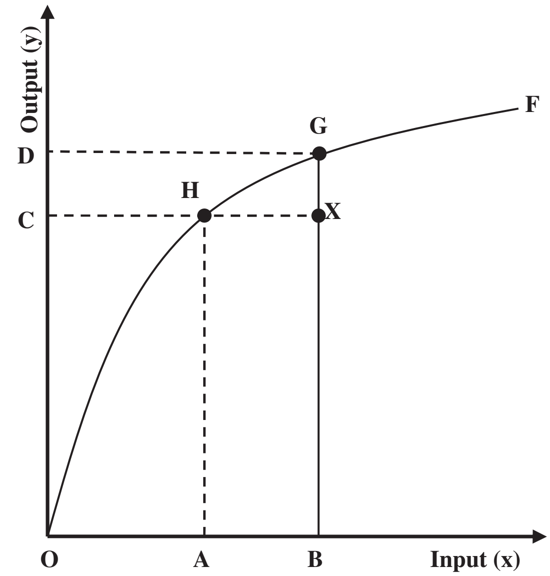
(DEA). The novelty of the technique is that it enables measurement of (comparative) efficiencies of the units without any information regarding the product and input prices. The data for this purpose has been collected from STP Kolkata, one of the nodal centres of its parent body Software Technology Parks of India (STPI). The data set considers the entire population (census) for the period of 15 years, Fiscal Year 1993 to Fiscal Year 2007 (FY93—FY07). The analysis carried out in this study is subject to the structure of the data set and its limitations.

We begin by exploring the theoretical underpinnings of the DEA technique in the next section, wherein the concept of the DEA is introduced using the simplest possible case of a firm that uses a single input to produce a single output. The graphical technique is then employed in order to measure the efficiencies and in the process, visualise the difference between the input- and output-oriented measures of technical efficiency. The single input-single output case is then generalised to account for multiple inputs-multiple outputs using the linear programming (LP) technique. The third section explores the nature and structure of the data set which has been collected solely from STP Kolkata. In the fourth section, we apply the DEA technique to the IT-ITeS industry in order to measure the efficiencies of the operating units and account for the variability in efficiencies across various segments of the industry. Concluding observations are made in the fifth section, including policy prescriptions.

Data envelopment analysis: theoretical considerations

In its purest form, DEA measures relative efficiencies of decision making units (DMUs) using multiple inputs in order to produce multiple outputs. These DMUs must be homogeneous entities in the sense that they must use the same set of resources for producing their output. For obvious reasons, proper identification of the inputs and outputs is crucial before incorporating DEA. The inputs must take into consideration all the resources that influence the output. On the other hand, the outputs must reflect all the possible outcomes that can be used to assess the efficiency of each DMU (Thanassoulis, 2001). When we talk of relative efficiencies, it implies that these efficiencies are compared with the efficient DMU (or DMUs). In our case, these DMUs are the firms that operate in the industry.

The novelty of the DEA technique is that it enables us to measure the efficiencies of the DMUs without any information regarding the product and input prices. This form of efficiency in the terminology of the DEA literature is known as "technical efficiency". Depending on whether output augmentation or input conservation is more important, two related measures of technical efficiency have been devised, namely technical output efficiency and technical input efficiency. The distinction between the two is illustrated in Fig. 1. It represents the simplest possible case wherein a single output is produced using a single input. The curve OF is the locus of maximum levels of output attainable from the given set of inputs. In other words, OF represents the efficient frontier. Given the frontier, DEA provides an efficiency score between zero and one, with a score of one assigned to those DMUs that are on the frontier. The DMUs that are on the frontier either produce maximum output given the input levels or use minimum inputs to produce given level of output. In the former case, a DMU is said to be "output efficient" and in the latter it is said to be "input efficient".



Output-oriented technical efficiency: OC/OD
Input-oriented technical efficiency: OA/OB

Figure 1 Technical efficiencies.

A representative DMU operating at X might have been operating at G so as to produce maximum output level OD, given its input level OB. On the other hand, it could have operated at H, by using the minimum possible input OA, for the given output level OC. Thus the DMU is not Pareto efficient for it can produce more output from a given input level, or use less input for producing a given output level. Hence, output efficiency can be defined as the ratio of actual output attainable from the given input to the maximum attainable output from that input, i.e. OC/OD. Conversely, input efficiency can be defined as the ratio of the minimum input required for a given level of output to the actual input required to produce that level of output i.e. OA/OB. Thus, the concerned DMUs may have different efficiency scores depending on the type of efficiency being considered.

The graphical analysis presented above considers the simplest possible case where a DMU uses a single input to produce a single output. Using the LP technique, the graphical analysis can be easily generalised to account for multiple DMUs, each using multiple inputs to produce multiple outputs. In the generalised version, we make the following specifications:

- There are N DMUs to be evaluated, producing m outputs from n inputs
- A representative DMU, say t, uses the input bundle $x^t = (x_{1t}, x_{2t}, \ldots, x_{nt})$ to produce the output bundle $y^t = (y_{1t}, y_{2t}, \ldots, y_{mt})$