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EFFICIENCY IMPROVEMENT THROUGH LEARNING

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Abstract: During the last decade, the measurement of technical efficiency indexes has become a very popular field of research. Recent refinements in estimation tools and techniques have contributed to increase the interest on efficiency analyses. The empirical success of the efficiency literature has been obscured by the lack of a rigorous theory explaining the sources of inefficiency. This article point to three components of the efficiency indexes as currently estimated: motivation, knowledge, and measurement error. We focus on the knowledge component to propose learning strategies that are based in the similarity between the inefficient firm and the benchmark firm.

Keywords: technical efficiency, knowledge, learning, benchmarking.

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1 Introduction

Technical inefficiency reflects the failure of some firms to obtain the maximum feasible output from the amount of inputs used. Research on efficiency and productivity analysis has been vast during the last two decades, but the bulk of the efforts were devoted to further develop the quantitative techniques available for empirical analysis. Many different indexes and computational procedures have been used in an endless list of empirical applications [1]. However, while efficiency measurement is important to quantify the magnitude of poor performances in a productive activity, it is not enough. The standard approach undertaken in the empirical literature on efficiency measurement consists in fulfilling the next four steps: 1) collect data on inputs and output(s) from a set of decision making units (DMUs) *assumed to be homogeneous*, 2) select the estimation technique—basically, econometrics or linear programming—that best suits the nature of available data or the type of indexes the author wants to obtain, 3) estimate the efficiency indexes, and 4) explain those indexes through the lens of a second stage regression analysis or analysis of variance. This last step involves searching for variables capable of distinguishing between efficient and inefficient DMUs. But, little is said about how can inefficient firms improve their productive outcomes in real practice.

In order to improve productive efficiency, firms should be able to identify the sources of misperformances and the alternatives available to make better use of their resources. Of course, the answer to this question depends on which are the sources of perceived inefficiencies. At this point, the empirical research gets in trouble. The huge advance that has taken place within the measurement field contrasts with the lack of a rigorous theoretical background on the very concept of "technical efficiency". Standard microeconomic theory of production does not consider the possibility that firm behavior may be inefficient, at least from a productive or technical point of view. The efficiency literature has evolved quite related to the analytical framework of the neoclassical theory of production, but the concept cannot be rationalized within the neoclassical approach. It is, thus, quite common to find efficiency papers that do not make any attempt to discuss the economic meaning of the indexes reported.

The objective of this article is to explore the sources of technical inefficiency and to suggest some strategies for efficiency improvement through learning. The paper is structured as follows. First, the traditional approach to the concept of productive efficiency is critically reviewed. Then, an interpretation of the components of inefficiency is outlined. This approach is argued to overcome some of the limitations of alternative interpretations. Finally, we discuss the role of learning on efficiency improvement and strategies to approach learning through benchmarking.

2. The traditional approach to technical efficiency

Following Koopmans [2], a DMU is said to be technically efficient if and only if it is not possible to increase any of the outputs or to reduce any of the inputs without reducing some other output or increasing some other input. The literature on the measurement of technical efficiency has strongly relied on this definition. Thus, a preliminary step before measuring efficiency indexes is to determine which processes are considered to be possible and which processes are not. This amounts to analytically represent the firm's *technology*. The different techniques at hand characterize the technology by establishing the set of input-output vectors that are considered to be feasible, i.e. the production set. Feasibility is usually established by means of well-defined technological properties [3]. Then, efficiency indexes are obtained by measuring the distance between the observed input-output vector and a benchmark, as defined by the frontier of the production set [4,5,6]. Figure 1 illustrates the common approach to efficiency measurement. The most productive DMUs shape the best practice frontier; then, efficiency is measured as the distance between the inefficient DMU and the frontier; there exist many different paths to measure distances, reflecting the preference of the researcher for different efficient benchmarks. Section 4 discusses the importance of the selection of an appropriate benchmark for learning.

"INSERT FIGURE 1"

The literature on efficiency measurement offers little guidance about *what are those distances actually measuring?* Empirically estimated indexes reflect the fact that some DMUs seem to perform better than others. But, what is the reason? Putting it in a different way, what are the sources of the inefficiency score we are measuring, where does it come from? Without answering this basic question, efficiency measurement would be of little practical use for managerial purposes. Surprisingly, although efficiency is a central concept in economics and management science, it is far from easy to find deep theoretical discussions of efficiency in production. The very notion of inefficiency violates central assumptions of mainstream economics. Within orthodox economics real observed output should always match potential output. Thus, we must replace the neoclassical assumptions with a more realistic view of the firm.

Perhaps, the only serious attempt to construct a theory of productive inefficiency is due to Harvey Leibenstein who coined the term “X-inefficiency” to refer to the amount of forgone output that occurs as a consequence of motivation deficiencies along the firm’s hierarchy. This theory is grounded on the assumption that the motivation to reduce production costs comes primarily from external pressures. For instance, a manager in a competitive industry would support more pressure to reduce costs than the manager of a monopoly. Leibenstein [7] stresses the importance of motivation when he analyses the possibility that suboptimal behavior may be due to a relative lack of knowledge. This last explanation of inefficiency would imply that any DMU obtaining more output without using more input than the average do so because it owns a superior knowledge background. Against this interpretation, Leibenstein points out that most of the improvement that seems to be achieved through better knowledge is actually induced by the pressures of motivation.

The theory of X-inefficiency departs from neoclassical theory in three main ways. First, labor contracts are described as incomplete. This implies that an unavoidable degree of effort discretion will be present in the behavior of workers and managers. Actual behavior is then ruled not just by contract but also by custom, authority, moral constraints, incentive systems, and other institutional arrangements. Second, not all factors of production are marketed. This is an important issue in the case of knowledge. The firm cannot buy all the required knowledge in the optimal quantity at the optimal moment. Unfortunately, this was not a central issue in Leibenstein's theory.

Third, the production function is not completely specified or known. A given input vector can result in different output vectors, depending on the motivational and organizational schemes.

In *The Xistence of X-Efficiency*, George Stigler [8] strongly criticized Leibenstein's notion of X-inefficiency (see also Leibenstein's [9,10] replies). First of all, Stigler denies that motivation has something to do with the quantity of output that is produced within a firm. The argument is very simple. People do not have a particular interest in maximizing any output, but in maximizing own utility levels. When the output increase is achieved through a higher effort, productive efficiency does not improve at all. Rather, a different output vector obtains, one that includes more physical product and less leisure. Parish and Yew-Kwang have expressed the same view: “If … (the inefficient firm) … prefers to take it easy, this may just be a form of producers' surplus. Nevertheless, it maybe held that … (the inefficient firm) … is indulging in satisfying non-essential wants. (But...) each man is the best judge of his own interest...” [11].

On the other hand, despite it is true that contracts are incomplete, a great quantity of (managerial) resources may be required to enforce contractual accomplishment to the point that maximizes production [12]. Positive agency theory has called attention upon this fact: the objective of management is not to minimize the residual loss (inefficiency?) but the total sum of agency costs, which also include formalization, monitoring, and bonding costs. Leibenstein theory falls into the *Nirvana fallacy*, a term coined by Demsetz [13] to refer to the common practice of comparing the real world with an ideal world to conclude that the real world is (relatively) inefficient.

The contributions from transaction cost economics, agency theory and property rights theory allow for a generalization of the neoclassical view of the firm, and a rationalization of the behavioral deviations that sustain the notion of X-inefficiency. Within this framework in mind, Leibenstein arguments can be reinterpreted by the statement that individuals react to environmental opportunities and constraints depending on their preferences—i.e., the gain derived from effort and the gain derived from leisure—and their budget constraints. The budget constraints include the own cognitive ability of people to perceive and scan the state of the environment [14,15]. This way, the theory of X-inefficiency can be accommodated within the framework of a more general theory of transaction and/or agency costs [16].

3. A resource-based interpretation of technical inefficiency

The theoretical difficulties with the concept of efficiency discussed above have not deterred the growth of empirical studies. Researchers have found important cost differences among firms in almost every sector of the economy and have interpreted these differences as the result of technical inefficiencies. Empirical measurement refers to relative efficiency indexes, which are obtained through comparisons among firms that are considered to be similar or homogeneous. Although this is the way the empirical literature has developed, it is evident that if some (efficient) firms do better than others (inefficient) this can only happen if they are *heterogeneous*. Some important differences between firms are not registered in accounting reports, given the inherent complexity of assigning a monetary value or even of identifying many critical resources. Thus, most efficiency differences reflect the existence of unregistered resources that are not being accounted for by researchers. These differences are what we are commonly calling (relative) “technical inefficiency”. The issue of productive inefficiency is, thus, an issue of heterogeneity and therefore investigating a more basic question can approach it more accurately: why are firms different?

The study of technical efficiency has been traditionally formulated on the basis of observable variables—physical inputs and outputs—and assuming an implicit common technology for all the firms that enter the analysis. This implicit technology is an oversimplification that represents the possibilities of transformation of physical and observable inputs into physical and observable outputs. But, in reality, the technology (possibilities of transformation, production set) differs across firms even in the same industry, because different firms usually possess some resources and capabilities, which are unique and play an important role. This type of resources includes intangibles, such as the firm's knowledge, culture, absorptive capacity, incentive systems, organizational routines, legal-contractual structure, and other institutional arrangements that evolve along time within the organization.

The resource-based view of the firm considers that the level of resource heterogeneity within an industry is typically high. Resource heterogeneity allows different firms to achieve different observable output levels from given observable inputs, generating economic rents that can be sustained from competition [17,18,19,20]. According to Dierickx and Cool [21], a useful analytical classification distinguishes *flow* from *stock* resources. Flow resources are those that can be immediately obtained whenever needed. In general terms, flows can be easily identified and a monetary value can be attached to them. Examples of this type of resources are machinery, human force and even market share. In contrast, stock resources generate internally from flows along a period of time through an *accumulation process*. Stocks are idiosyncratic resources deeply embedded within the firm and thus imperfectly mobile. Thus, a market cannot exist to exchange this type of resources. Available data for efficiency estimation is usually limited to flow variables, even though stock variables and complex capabilities may constitute the most valuable assets employed by the firm. Figure 2 summarizes some of the resources and capabilities that distinguish firms and are not typically accounted for in efficiency measurement experiments.

“INSERT FIGURE 2”

Related to motivation—and thus to X-inefficiency—are factors such as firm culture, firm routines or incentive schemes, that evolve over time and can be considered as the basis of the contractual part of the firm technology. Under the heading knowledge we identify resources such as the production techniques, the know-how, and the managerial capabilities of the firm. These capabilities constitute an important part of what is commonly integrated in the production technology. The third component refers to input heterogeneity. When these inputs are taken to be homogeneous, the actual technology of the firm is misrepresented. Firms usually differ in input quality and the skills and involvement of the workforce. Farmers, for instance, may use feedstuffs of different quality, although efficiency analyses rarely take this fact into account [22]. If this is the case, farmers with different input quality are virtually using different technologies.

Therefore, it is possible to interpret current technical efficiency indexes as indicators of firm heterogeneity. More precisely, observed technical inefficiency arises from heterogeneity in resources and essential capabilities that are not included as inputs in the efficiency model and are related to motivation, knowledge, and use of superior inputs [23]. The third component of inefficiency indexes may be also interpreted as measurement error, because it comes from an inappropriate account of the inputs actually used by the firm. In any case, the average efficiency level would indicate the level of interfirm technological heterogeneity. Thus, the emphasis of efficiency analyses should not be placed on the *measurement* part—i.e., computing how inefficient each firm is—-but on the *benchmarking* part—identifying the key success factors that determine the technological capabilities of best practice firms.

4. Improving efficiency through learning

As we have indicated above, some studies consider technical efficiency as the result of a lack of motivation or effort. If this is the case, the question of efficiency improvement may be assessed within the framework of principal-agent contractual theory. In this line, Bogetoft [24,25] has suggested that efficiency improvements may be achieved introducing an appropriate incentive scheme to induce the desired effort level from the agent. The design of appropriate incentive schemes, in the spirit of principal-agent models, would be of most concern. A second approach considers technical inefficiency as the result of a lack of knowledge or managerial ability. Under this view, efficiency improvements may only be achieved through learning processes, as is the case of management programs. We focus now on the knowledge-based view of efficiency, which focuses on firms that are inefficient, have the motivation required to become efficient, but lack the knowledge about the sources of misperformances.

The identification of the sources of inefficiency is crucial. Efficiency indexes inform of the potential input reduction that a firm may achieve. However, if an inefficient firm reduces its input use but continues acting in the same manner as before the reduction, we would observe a firm that produces less output and is still equally inefficient. Thus, before reducing costs, the inefficient firm needs to find out what it is doing wrong and then correct its own behavior. The question is how to do this in practice. We can distinguish between two types of knowledge at this point. Technical knowledge refers to operational issues concerning the production process. Normally, most of this knowledge is available in the market for well-established technologies. For instance, in the case of agriculture, farm management journals, farm suppliers, extension programs, and agribusiness associations provide continuous flows of such information. A second type of knowledge is organizational or managerial knowledge. This knowledge refers to organizational issues that compromise the level of technical efficiency, and includes questions as human resources management, inventory, bargaining with suppliers and customers, etc. This type of knowledge is harder to find in the open market. The extent to which both types of knowledge is recognized as valuable and assimilated by the inefficient firm depends upon its level of "absorptive capacity" [26]. However, the acquisition of the first type of knowledge is relatively easier than the second, as it may be passively learned from journals, seminars, and consultants [27].

To acquire this second type of knowledge, the firm must follow more active forms of learning, such as benchmarking. After the firm knows about its inefficiency, its manager may visit some of the efficient firms to observe how they do things. Benchmarking is very common in farm management programs and also in other sectors, particularly in service sectors. If the firm follows this strategy, a non-trivial question is how to choose which of the efficient firms should be taken as benchmark. It seems natural to think that the inefficient firm will prefer to visit the efficient firm that is most similar to it, rather than an efficient but very different firm. Research on interorganizational learning supports this idea. As Lane and Lubatkin [27] put it "(…) the ability of a firm to learn from another firm (…) depends upon the similarity between the student and the teacher firms". The most similar the efficient firm, the easier it will be for the inefficient firm to detect its own mistakes and, therefore, to correct them.

Knowledge complementarity —the degree of overlap between the knowledge bases of the learning and the benchmark firms— has been also recognized as a variable that enhances the firm's potential absorptive capacity [28].

Can the efficiency measurement literature provide any guidance about similarity? The answer is yes. Most empirical studies of productive efficiency use radial measures and, thus, it may be argued that the most similar firm is the radial projection of the inefficient firm on the best practice frontier. Radiality seems to be a reasonable proxy for similarity, because all firms on the same ray share the same combination of inputs. However, it is easy to imagine a situation in which two firms sharing the same input proportions may be quite different. A better criterion may be proximity, measured in terms of the inputs used. The literature on farm management provides some examples. For instance, Lund and ∅rum [29] have developed a computerized efficiency analysis system for management advisory purposes that compares each firm with a reference group composed of the most similar firms in terms of absolute quantities of certain inputs. Similarly, Frei and Harker [30] and González and Álvarez [31] have proposed empirical methods that allow inefficient firms to benchmark against those efficient firms that most closely resemble them. Cluster analysis could also be used to find out which firms are more similar to the inefficient firm and then select one that is more efficient as the benchmarking target.

Strategic groups analysis can also be of help. Instead of using inputs to define similarity the researcher can take variables that approximate the strategic position of the firms that are under analysis. There are different procedures to classify firms into strategic groups. Once the strategic groups have been established an efficiency analysis can be conducted using data on inputs and outputs. The most efficient firm within each strategic group can be taken as a strategic leader. According to our resource based view of inefficiency, this firm possesses the knowledge, skills, capabilities, know-how, incentive schemes, firm culture, etc that adds more value to production, within a given strategic group. Inefficient firms within the strategic group can focus their learning activities around the strategic leader.

While in competitive markets, strategic leaders may try to maintain their success secrets hidden, this learning strategy can be easily implemented in the public sector or in public management programs, as agricultural extension. For instance, research and teaching productivity in economics departments is an issue of high concern in Spain, where most universities are publicly owned. An empirical analysis of efficiency may reflect learning possibilities for inefficient departments. However, learning must focus around similar departments. An inefficient department in a small town in Spain will probably learn many things it its managers go visiting the Harvard Business School to see how things are organized and how do they manage knowledge. But this inefficient department may lack the resources necessary to implement the Harvard success strategy.

"INSERT FIGURE 3"

Figure 3 illustrates the importance of selecting an appropriate benchmark to be effective in a learning strategy oriented towards efficiency improvement. The first case represents the extreme situation in which the knowledge pools of the inefficient and the learning firms are completely unrelated. In such cases, although the potential for learning is great, the student firm lacks the capacity to assimilate and implement that knowledge. Case 2 shows a situation in which the knowledge of the student and the teaching firms are partially related. Benchmark firms contained in Case 2 can be considered as potential teaching firms, because the student firm will assimilate some valuable knowledge. Case 3 represents the most interesting case in a benchmarking strategy. The basic prior knowledge of the student firm will allow to fully recognize the value of all the information received from the teaching firm and to implement the new learned production or organizational practices.

How does this picture relates to the different measures of productive efficiency discussed above. Current Farrell-radial measures of technical efficiency do not account for the similarity between the inefficient firm and the benchmark. As such, a benchmarking strategy based on radial efficiency measures may end up in a Case 1 situation. Of course they also may end up in any of the other cases, because similarity is simply not accounted for. Non-radial measures of efficiency such as those proposed by Frei and Harker [30] or González and Álvarez [31] search for the most similar efficient firm, where similarity is measured as the distance between the inefficient firm and the benchmark in the input-output space. It is likely that these measures will end up in a Case 2 situation where, at least, there exist some relationship between the basic prior knowledge of the learning firm and what it can learn from the benchmark. Finally, combining strategic groups analysis with technical efficiency analysis may provide the information required to approach the situation represented by Case 3. Once the efficient benchmarks have been established by means of an efficiency analysis, learning will restrict to firms within the same strategic group of the inefficient firm. Of course, this last strategy requires complete data on inputs, outputs, and strategic variables, which makes its implementation more difficult in practice.

5. Conclusion

Empirically estimated indexes of relative technical efficiency are obtained under the assumption that all the firms in the sample use a common technology. In our view, the *homogeneity postulate* amounts to assume that all relevant resources and outputs have been taken into account. However, under the homogeneity assumption no theory is available that explains the observed performance differences that arise between *identical* firms. The resource-based view of the firm offers a consistent explanation of empirically estimated inefficiency indexes. Firms' resources and capabilities are widely heterogeneous, even within the same industry. It is precisely resource heterogeneity what explains observed stable differences in total factor productivity.

We claim that observed inefficiencies may arise from three sources: a lack of motivation, a lack of knowledge, and measurement errors. To improve its efficiency level, an inefficient firm must act upon the first two components of the efficiency index, while researchers on measurement tools may concentrate in the last one. The motivational component of inefficiency relates to incentive schemes within the organization. A careful design of the principal-agent relationship may contribute to eliminate this source of inefficient [24]. The second component of the inefficiency index relates to a lack of knowledge about the production practices or the organizational arrangements that produce the best productive results. To improve on this component, the firm must pursue a learning strategy. Some knowledge may be acquired in the open market, as it refers to technological or standard organizational aspects of production. This knowledge has been articulated and configures the common pool of knowledge within a specific activity. Actually, the availability of this type of knowledge makes it unlikely to be a main source of observed inefficiency. A passive approach to learning (seminars, journals, consultants) may be enough to acquire this knowledge. More active learning strategies are required to acquire the more specific knowledge that relates to how do the other firms do things in practice. This knowledge refers to hard to articulate organizational and managerial aspects of production. Benchmarking is a common learning strategy to acquire this second type of knowledge.

This paper advocates for a careful selection of benchmark firms in order to obtain the highest performance from benchmarking practices. The literature on efficiency measurement offers little guidance as to the selection of appropriate benchmarks. The literature on organizational learning can shed some light at this point. The theory of absorptive capacity [26,27] has pointed to similarity between the student and the teacher firms as the main driver that determines the learning capacity. Similarity can be measured in the input-output space [30,31] and also in the strategy space [32]. These strategies to determine the appropriate benchmark will contribute to improve the results of benchmarking learning processes.

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Tables and figures

Figure 1. Measurement of relative technical efficiency

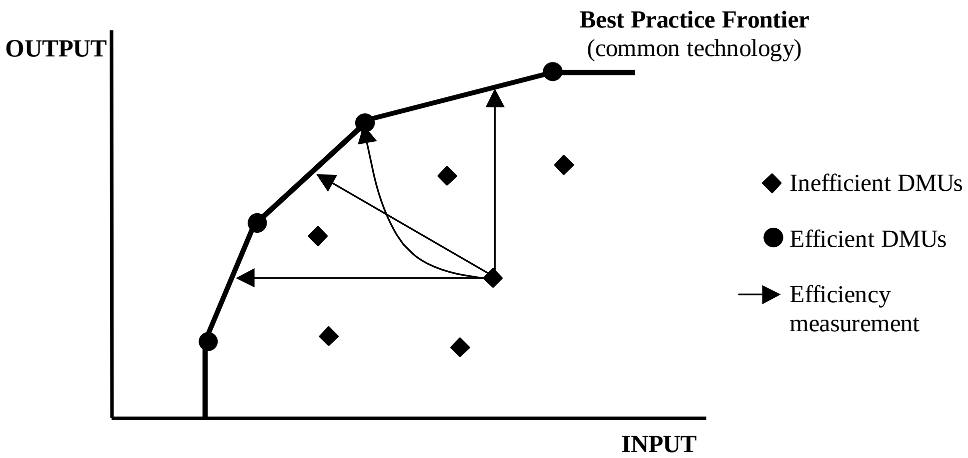

Figure 2. Factors and resources underlying the firm's technology

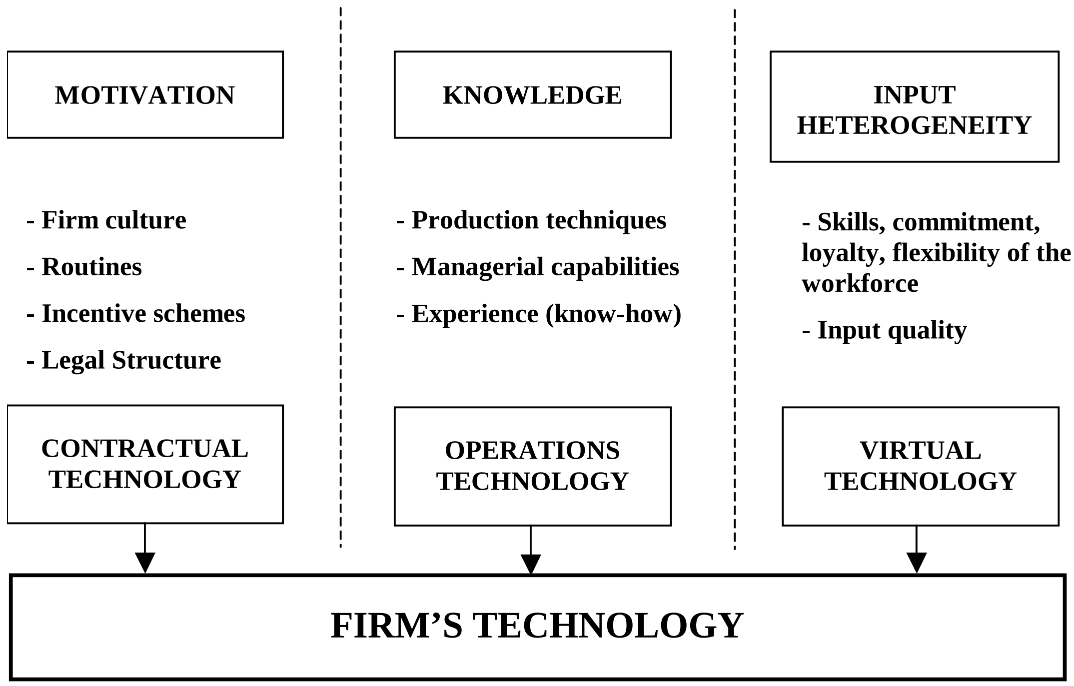

Figure 3. Relative Absorptive Capacity