Strategic Modelling of Productive Efficiency

INTRODUCTION

To analyse a firm’s productive efficiency, statistical data is required. Despite possible influences of technostructure and qualitative attributes on productive efficiency, published statistics still reflect mainly the operational aspects of productive efficiency. Taking an organic, system perspective [1], a manufacturing firm may be conceptualised as an “organism” that absorbs inputs from the external environment. Through the process of production value is added. Transformed inputs are then re-channeled into the external environment as outputs. The survival of such an organism is a function of its ability to generate sufficiently valuable outputs. This is a necessary condition for the value-creation process to be reinterpreted continuously. Firms so visualised as “living” organisms compete through superior value-adding capabilities. Further, such a firm can be seen to comprise of three main structural components—the operating core, physical/support elements and technostructure [6]. Each structural component will be explained in turn.

The operating core is involved directly in the production process of value-adding. The technostructure relates to the more structural aspects such as machineries, computer software, automation technology, core human skills. These tend to integrate more intimately with the production process. The physical elements form the framework which a firm needs to manufacture products. These include fixed assets such as the building, land, and office furniture. The support elements are physically less obvious, for instance expenditure on administration. Relative to operating core and technostructure, the physical/support elements have less direct, integrative relationships with the production process. Qualitative attributes (corporate philosophy or values) though integral aspects of the organisation structure are impossible to model using mathematical identities. The next section explains how the influences of each structural component on productive efficiency may be modelled.

APPROACH IN MODELLING

An intersectional approach in modelling productive efficiency is suggested—the structural configuration of the firm, mathematical identities and published sources of industry data. Net value-added per employee is employed as the primary indicator of a firm’s productive efficiency. The model seeks to relate the contribution of each structural component to changes in productive efficiency. A mathematical identity is developed that interrelates components of organisation structural configuration to productive efficiency. To reflect an aggregate systems dimension to productive efficiency analysis, references are made to census of industrial production (CIP) reports. The choice of the ratios are necessarily constrained by published data items. Value-added (VA) is defined in Singapore’s CIP survey as gross output (O) less work given out (WGO) and inputs (I). The focus is on net value-added per employee (being that of the gross amount of value added less other cost of production or OCP). We begin by,

\[ VA = O - WGO - I \]

Now, if \( VA = VA - OCP \)

Then,

\[ VA/E = (VA - OCP)/O \times O/E \]

\[ = ((O - WGO - I) - OCP)/O \times O/CE \times CE/E \]

\[ = (1 - WGO/O - I/O - OCP/O) \times O/CE \times CE/E \]

The primary ratio of Net \( VA/E \) reflects the capability of people in a firm with its specific technostructural configuration to add value to inputs. \( (VA - OCP)/O \) reflects the productive efficiency of a firm’s operating core. \( O/CE \) and \( CE/E \) captures the intensity a firm’s efforts in improving performance through capital expenditure. Capital expenditure can alter a firm’s technostructural configuration. For instance, investments in new technologies can have immediate impacts on productive efficiency. In comparison, efficiency gains from investments in workers’ skill development will take longer to materialise. Further refined
analysis of operating core efficiency is possible using available published data items,
\[ (1 - \frac{WGO}{O} - \frac{[RM;O + F;O}{O} \]
\[ + \frac{EI;O + W;O}{O} \rightarrow \text{Operating core} \]
\[- \frac{[R,o;O + R,m;O + R,t;O + D;O + OE;O]}{O} \]
\[ \rightarrow \text{Physical/support} \]
\[ \times \frac{(O;CE \times CE;E)}{E} \rightarrow \text{Technostructure} \]
since
\[ I = RM + F + EI + W \]
and
\[ OCP = R,o + R,m + R,t + D + OE \]
where
\[ VA = \text{value added}; \]
\[ E = \text{number of employees}; \]
\[ OCP = \text{other costs of production}; \]
\[ O = \text{output}; \]
\[ CE = \text{capital expenditure}; \]
\[ I = \text{inputs to production}; \]
\[ RM = \text{raw materials}; \]
\[ F = \text{fuel}; \]
\[ EI = \text{electricity}; \]
\[ W = \text{water}; \]
\[ R,o = \text{rent for office/factory premises}; \]
\[ R,m = \text{rent for machinery}; \]
\[ R,t = \text{rent for transport equipment}; \]
\[ D = \text{depreciation}; \]
\[ OE = \text{other expenditure}. \]

By constraining the model to published data items, direct comparisons of the firm's ratios with the industry can be made. Analysis may be in terms of the incremental rates of change of longitudinally, over a period of years. The next section explains why public sector firms should make such comparisons.

**PRODUCTIVE EFFICIENCY COMPARISONS WITH AGGREGATE SYSTEMS**

The measurement of efficiency in public sector is known to be fraught with comparability issues [7, 3]. In contrast, for the private sector firms, ratios derived from CIP surveys are more immediately comparable. Despite this, firm productivity measurement models proposed for application [5], still fail to take explicit account of relative to industry performances. Yet, keen competitiveness and environmental uncertainty are conditions that prevail across many industries. Such conditions demand pro-action (acting to counteract latent problems) rather than re-action. There are other cogent reasons for making industry comparisons.

*Firstly*, even for firms with productive efficiency levels higher than their specific industries, they should be concerned whether these levels are sustainable. Competitor firms in the industry may be quickly narrowing the productive efficiency gaps. For firms enjoying the productive efficiency edge, the problem becomes a strategic rather than a tactical one. These firms need to pro-act if competitors are narrowing the productive efficiency gaps. For instance, new strategic plans need to be formulated. These may lead to one or more of such moves—diversification, investments in new technologies, changes in human resource management practices. *Secondly*, early warning signals can be embedded in the rates of change (rather than just the differences in levels) in the productive efficiency of the firm relative to the industry. Operations analysts should utilise CIP data to detect threats that remain submerged. This, especially, of the potential for sharp improvements in productive efficiency within the firm's industry. By detecting the development of such trends, firms are then able to formulate effective counter-strategies. Operations analysts generally are not able to utilise such analysis to advantage. In-depth analysis may reveal latent problem of a fundamental nature. For example, firms may face the problem of maintaining price competitiveness over the long term. Indeed, there is a dire need for strategic orientation by operations analysts.

**MODEL REFINEMENT AND CENSUS OF INDUSTRIAL PRODUCTION SURVEY**

The current "operations orientation" by OR analyst had been keenly observed—"... The OR analyst tends to have a fairly narrow orientation, his obsession with quantitative modelling requires 'hard' data to feed into his models, and he therefore tends to concentrate on current operations for which reliable information can be obtained... The result is that OR tends to be concerned with tactical problems and reports to middle management, so that its contact with top management and strategic problems become rather limited..." [2]. The type of statistical data collected and published by the authorities further reinforces an operational orientation. As illustrated earlier, CIP data items tend to concentrate on the operating core (e.g. utilities) and physical elements (various rents). There should be scope for gathering data items that yield more than just operational efficiency insights. Detailed information (5-digit level) concerning aspects of expenditure related to techno-structure or support elements are clearly lacking. A distinction should be made between technology-related and purely
physical capital expenditure [4]. Thus, factory-automation expenditure should be separately shown. Computerisation or expenditure on the upgrading of management information system is another. Although these provide insights to the extent of hard, technological changes within an industry, the soft aspects can be equally important to operations analysts. For instance, there may be efficiency gains from human capital expenditure such as quality circles training. If details are available, \( CE/E \) may be disaggregated further:

\[
CE/E = (\text{Physical } CE + \text{Technological } CE + \text{Human resource } CE)/E
\]

Each of these may be disaggregated further, including for example:

- Physical \( CE \) = land, building, structures, transport, equipment.
- Technological \( CE \) = machinery, equipment, plant automation, management information system.
- Human resource \( CE \) = training for top, middle-level, supervisors, clerical staff and production workers.

The incremental cost to the statistical authorities should be minimal. Also, these details should be published expeditiously. Perhaps then, models of productive efficiency may be more strategic rather than operational in character.

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REFERENCES


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