Factor Analysis Approach to Investigate Productivity in Indian Sugar Industries: A Financial Ratios Approach

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Abstract
Indian sugar industry has proved itself to be a nucleus of rural development by providing employment to about 7.5% of rural population and provides a significant contribution to Indian Economy. Thus, the performance of Indian sugar industry plays a significant role in Indian economy. The performance of sugar industries depends on several factors. The paper discusses the factors affecting the Indian sugar industries and explores the possible methods to improve its productivity. Strategic productivity management is one of the major strategies to overcome the problems faced by Indian sugar industries. Since a firm’s productivity can be evaluated in terms of financial ratios, financial factors can be used as a means of managing productivity. Selection of financial ratios from the available set of published ratios is done by correlation study between Total Factor Productivity (TFP) and financial ratios. Financial factors influencing productivity are obtained using factor analysis. The paper also proposes a set of possible ways by which productivity management could be done in Indian sugar industries.

Keywords: Sugar industry, productivity, financial ratios, financial factors, fuzzy clustering, and system dynamics

Introduction
Sugar is produced in 110 countries. The leading sugarcane producing countries are Brazil, India, Australia, Thailand, China, and Cuba. The production of sugarcane is affected by international trade agreements and domestic price support programmes [1].

Sugar industry in India is the largest agro-based industry located in the rural India. About 45 million sugarcane farmers, their dependents and a large mass of agricultural laborers are involved in sugarcane cultivation, harvesting and ancillary activities, and constituting 7.5% of the rural population [2].

Sugar economy is driven by its consumption. The most important factors, which influence sugar demand identified by economists, are [3]:

a) Per Capita consumption
b) Population growth
c) The price of sugar and alternative sweeteners
d) Availability
e) Consumer preferences
f) Technological advances
g) Government Policies

Population growth and per capita consumption have been recognized as the most important factors. Calculations shows that rise in population explain 85% of the increase in off take. In this context, it is important to see long term forecast for sugar and the performance of the Indian sugar industry.

Serious doubts about the competitiveness of Indian sugar industry have been raised despite its large size and significant contribution to the rural economy of India. The doubts are further compounded by several factors and are discussed in the next section.

A. Major Issues and Problems in Indian Sugar Industries
It is important to understand that fortunes of sugar industry and sugar cane farmers continue to swing rather viciously in a cyclical period of 4 to 5 years as shown in the figure 1, there by seriously undermining the larger interests of sugar cane farmers, industry and sugar consumers. These oscillations are caused due to variations in natural factors, but these are accentuated due to lack of long-term policy. Corrective measures were put in place but purely on adhoc basis after considerable lapse of time. As a result, even the corrective measures fail to create desired impact on time and in meanwhile, the emerging difficult situation continues to drift [2].

Apart from the impact of sugar cycle, Indian sugar industry is facing several problems like:

a) Government policy is frequently changing from emergency imports to limited and canalized exports and even to liberal and de-canalized exports with consequent controversies.

b) Sugar being an essential commodity and the Government regulations are quite widespread. Besides directly and indirectly subsidizing an irrigation and fertilizer-intensive crop like sugarcane, the government has been promulgating statutory minimum prices (SMP) and state advised prices (SAP) in the interests of the producers. In order to protect the consumers, it is imposing levy on sugar production and control on release to the market of levy-free sugar, besides putting restrictions on storage, use and movement of sugar as well as some of its by-products.
c) International Sugar markets over coming years will be increasingly shaped by market developments occurring in the developing countries and transition economies which collectively account for over 70% of the world production and consumption and the largest share of global raw and white sugar trade [4].

d) For the sugar market, world indicator prices had swelled to quarter-century highs during the 2005/06 marketing year, almost doubling in the span of two years. However, their subsequent decline in 2006/07 as sugar balances moved into surplus has been equally dramatic, particularly for raw sugar, which fell 27% and Sugar prices will remain under pressure throughout the outlook period [5].

e) Energy requirements of India are increasing day by day, Ethanol a by-product of the sugar industry can help in meeting a small requirement of the energy sector, thus saving a lot of foreign exchange.

Major problems faced by Indian sugar industry are high stocks, low prices, (prices swing based on sugar cycle), poor profitability, mounting cane price arrears, financial crunch (or outright sickness), limited modernization/expansion/diversification, weak international competitive edge, and non-favorable Government policies etc.

B. Need for Productivity Management in Indian Sugar Industries

Sugar industry’s contribution to the economy is enormous and its performance plays a vital role in Indian rural economy. It is a widely accepted fact that, productivity and its management is a key performance benchmark for firms involved in the manufacturing sectors. Improvement and management of productivity is related to increased profitability, lower costs and sustainable competitiveness. It is important that business managers consider productivity as a performance measure for the firm’s production activities. Productivity as a performance measure can be utilized to transform the firms from where they are and where they shall be. In the current situation where sugar industry in India is going through tough times has to manage productivity strategically, to help them perform in a better way.

Sugar industry in India is playing a vital role in the development of rural sector, and long-term sustainability of the sugar industry is an important factor in the economy of the rural India, hence rural sector. Increased productivity in Indian sugar industry can play a major and important role in the development of rural sector. Productivity management will aid in the process.

2. Productivity Measurement

A very early appearance of the term productivity was used by Quesnay (1766) in the Journal de l’Agriculture over two centuries ago. Since then, it has been applied in many different circumstances at various levels of aggregation, particularly in relation to economic systems [6].

Measurement and analysis of productivity related performance of an organization is an ever-increasing issue for firms that are concerned with gaining a competitive edge. Understanding and implementing an appropriate productivity measurement system is a required management tool in evaluating and monitoring the performance of a business operation. Productivity is a major concern in today’s business organization, which enables them to survive and be profitable. Hence, there is a growing need for the managers to become familiar with productivity and its measurement.

There are several approaches to the productivity measurement in the literature. The choice between them depends on the purpose of productivity measurement and, in many instances, on the availability of data. Commonly three traditional types of productivity measures as distinguished by Sumanth [7] are:

a) **Partial productivity measures** - ratios of output to one source of input, such as labour, capital, material or energy.

b) **Total-factor productivity measures** – ratios of net output to the sum of associated labour and capital input. This type of productivity is sometimes referred to as value added productivity or multi-factor productivity.

c) **Total productivity measures** - ratios of total output to the sum of all input factors.

The limitation of partial productivity measures is that they attribute to one factor of production- (labour, capital, material or energy) - while changes in efficiency at-
The development of a more comprehensive measure; multifactor productivity. One of the more commonly used measures of multifactor productivities is that of Total Factor Productivity (TFP). Total factor productivity measures are usually based on net output (value added) rather than gross output as explained by many authors including Parsons (2000)[8], Grossman (1993) [9], Craig and Harris (1973)[10] and Liang-Hsuan Chen et al., [11]. Output is measured on a value added basis, i.e., the value added by the company or industry to a product. Total-Factor Productivity (TFP) provides a comparably good picture of the overall productivity. A major advantage of TFP is that, it accounts for capital-labour substitution. Another advantage is that, can be used to compare across different companies.

Although the definitions of productivity differ, they all use the ratio of output to input to measure productivity. In this paper, we have adopted the TFP model given by Taylor and Davis 1977[12]. Mathematically TFP is defined as:

\[
\text{TFP} = \frac{O}{L + C}
\]

Where: \( O \) = Total factor productivity
\( L \) = Labour input
\( C \) = Capital input
\( O \) = Value added output

Inputs: Inputs must include everything the business physically uses in the manufacture of the output. This study considers labor inputs (L) as a kind of expenses related to employees, including direct labor, indirect labor, marketing personnel, managers etc. Capital inputs consist of both fixed capital inputs and working capital inputs. Fixed capital includes depreciable assets, such as plant building, machinery, equipment, tool, and so on, together with non-depreciable assets, such as land. These inputs are evaluated by depreciation or by rent [13]. Working capital is assessed through the difference between current assets and current liabilities [14], [15].

Outputs: Value-added measure of output has been used (it can easily be computed from company financial statements). Value-added measure of output is defined as the production due to the efforts of labour and capital. The costs of materials and energy inputs are excluded. A popular method of measuring productivity is the concept of value added per unit of resource. Value-added (VA) allows us to consider the firm’s net contribution generated by production activities during a period [16], [13].

Sugar industry in India, is going through a phase where productivity management as a strategic tool will become imperative.

3. Financial Ratios

Financial analysis is the process of selection, relation and evaluation of information relevant to the decision under consideration, it forms the total information contained in the financial statements. Thus, the focus of financial analysis is on key figures in the financial statements and the significant relationship that exists between them. Ratio analysis is one of the most widely used techniques of financial statement analysis. Ratio analysis is defined as systematic use of ratio to interpret the financial statements so that the strengths and weaknesses of a firm as well as its historical performance and current financial conditions can be determined. The term ratio refers to the numerical of quantitative relationship between two items of variables.

Ratios are highly important measures of profit tools in financial analysis, that help financial analysts implement plans that improve profitability, liquidity, financial structure, reordering, leverage, and interest coverage. Although ratios report mostly on past performances, they can be predictive too, and provide lead indications of potential problem areas.

Having reviewed the parameters in productivity and financial ratios, the financial ratios reflect the health of organization. These financial ratios data is made available by most of the companies, hence they were used as an apt measure of productivity. Hence, productivity measures are reflected through these ratios and data collection on these ratios has been used for collating to TFP.

4. Data Collection And Selection Of Financial Ratios

The data for calculation of Total Factor Productivity of sugar industries is used from PROWESS database provided by Centre for Monitoring Indian Economy (CMIE). The sample size for the study consists of data from 908 sugar industries over a period of 20 years. After conducting the anomaly detection procedure and removing the unusual cases, number of cases in the sample was reduced to 693. TFP for all these companies is calculated and the normal Q-Q plot revealed that the productivity distribution of the sample firms is determined to be normal, which indicates that the information from the sample firms is representative of sugar industries in India.

There are about 87 financial ratios provided by PROWESS on the financial performance of the companies in the form of financial ratios. These ratios have been reduced into manageable number of ratios using the correlation technique for further analysis.
A. Selection of Ratios

A correlation study was conducted between TFP and financial ratios to find out the ratios highly correlated with productivity [11]). PROWESS provides us with the ratios, which are similar in nature; for example, in the margin ratios we have ratios like PBDIT (NNRT), PBDT (NNRT), PBIT (NNRT), PBT (NNRT), PAT (NNRT) as a % net sales. Instead taking all the ratios for the study, we have calculated the absolute correlation between TFP and these ratios, the ratio with the highest correlation is taken for further analysis as discussed in Table 1. Similar procedure is adopted for selection of ratios for further analysis. The total number of ratios selected after correlation analysis, researcher’s knowledge in this field is 23. An F-test is performed to examine the relationship of these ratios with Total Factor Productivity (TFP) of the firms. A significant conclusion is made (p-value = 0.00) for this test, indicating that these ratios are effective in describing total factor productivity (TFP).

Factor analysis is applied to find critical financial factors to describe the above ratios, which can be used for further analysis. Factor analysis approach to financial ratios is explained in the next section.

Table 1. Example showing the procedure for selection of ratios and Abbreviations Used

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Ratio</th>
<th>Correlation with TFP</th>
<th>Absolute Correlation</th>
<th>Highest Absolute Correlation Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Profit before depreciation Interest and Tax [PBDIT (NNRT)]</td>
<td>0.4723</td>
<td>0.4723</td>
<td>PAT (NNRT) 0.7118 (This ratio is considered as representative ratio for further analysis)</td>
</tr>
<tr>
<td>2</td>
<td>Profit before depreciation and Tax [PBDT (NNRT)]</td>
<td>0.6862</td>
<td>0.6862</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Profit before Interest and Tax [PBIT (NNRT)]</td>
<td>0.5304</td>
<td>0.5304</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Profit before Tax [PBT (NNRT)]</td>
<td>0.6969</td>
<td>0.6969</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Profit after Tax [PAT (NNRT)]</td>
<td>0.7118</td>
<td>0.7118</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Net of Non-recurring transactions [NNRT]</td>
<td>0.6566</td>
<td>0.6566</td>
<td></td>
</tr>
</tbody>
</table>

5. Factor Analysis Approach To Financial Ratios

Factor analysis provides the tools for analyzing the structure of the interrelationships (correlations) among a large number of variables by defining sets of variables that are highly interrelated, known as factors. The objective is to find a way of condensing the information into a smaller set of variables, which can account for covariance among a larger set of observed variables with a minimal loss of information. Factor analysis can simultaneously manage many variables, compensate for random error and invalidity and disentangle complex interrelationships into their major and distinct regularities [17].

Factor analytic techniques can achieve their purposes from either an exploratory or a confirmatory perspective. The exploratory analysis does not set any a priori constraints on the estimation of components or the number of components to be extracted. In the case of confirmatory situations, the researcher has preconceived thoughts on the actual structure of the data, based on the theoretical support or prior research and assesses the degree to which the data meet the expected structure [18]. The data of 663 companies with 23 ratios (variables) was fed into SPSS-15 software for factor analysis.

A. Sample Adequacy and Validity Test

Literature on factor analysis prescribes that there be at least five variables for each variable, while the sample, size less than 50 is considered as unfit for factor analysis. The present study consists of 23 variables and a sample size of 663; hence, the sample size may be considered adequate.

Kaiser-Meyer-Olkin (KMO) is one of the tests performed to find the applicability of factor analysis. Kaiser [19] [20] mentioned that KMO value in excess of 0.9 might be considered as meritorious and the study value was found to be 0.839, which is close to one and more than minimum of 0.5, use of factor analysis was found to be relevant. Barlett test of sphericity for the data under consideration, the significance level was found to be 0.000, which is less that 0.05. This indicates the presence of correlations among variables.

B. Extraction of Factors

The data was subject to exploratory factor analysis using principal component analysis as the extraction method and Varimax as the rotation method. The Eigen value criterion, also called as Kaiser-criterion [21] and Scree-test criterion was used to determine the initial number of factors to be retained. The factors having Eigenvalue more than 1 are important for analysis [19] [20]. The six extracted factors with Eigen value more than 1 explained 84.566 % of total variance. This value is in line with the similar studies on financial ratios by M Emin et al. (2007) [22], which explained 84.109% of total variance, and Chen et al., (2001) [11] which explained more that 80% of total variance. The variables used in the study, abbreviations used for the variables (ratios), factors loadings and results of the factor analysis are shown in the table 2.

Factor 1: This factor explains 24.729 % (rotation sums of squared loading) of the variance contains seven ratios (variables) and has a Cronbach’s alpha of 0.802. This indicates a good internal consistency among the variables of the factor. All the variables included in this
factor are related to profitability hence the name ‘profitability factor’. Profitability ratios are used to measure the operating efficiency of the company. Management of the company, owners and creditors are interested in profitability of the company.

**Factor 2**: This factor explains 21.806 % of the variance contains six variables and has a Cronbach’s alpha of 0.880. This factor is termed as ‘Retained profits factor’ as most of the variables connote to the retained profits. Retained profits play a major role in the performance of a sugar industry, The variables in this factor assess the retained profits as percentage of capital employed, total assets, gross fixed assets, total debt and net worth. All these parameters are important in assessing the performance of the Indian Sugar industry.

**Factor 3**: The financial ratios included in this factor are all related to inventory. This factor also indicates the efficiency of the firm in producing and selling its products. Based on the absolute values of factor loadings, four financial ratios are included in the factor. The ‘inventory factor’ explains 12.456 % of the variance, and has a Cronbach’s alpha of 0.732.

**Factor 4**: The ‘financial leverage factor’ explains 9.093% of the variance. The factor has two variables and has a Cronbach’s alpha of 0.998, which is highest among all the factors, is an indication of good internal consistency. Financial leverage refers to the use of debt finance. The short-term creditors like bankers and suppliers of raw materials are more concerned with the firm’s current debt paying ability.

**Factor 5**: Working capital on long term is required to determine whether or not, adequate working capital will be generated to meet the firm’s expansion [15]. The ‘working capital factor’ explains 9.068% of the variance. The factor has two variables and has a Cronbach’s alpha of 0.732. Working capital as percentage of total assets and borrowings will play an important role in strategically managing the TFP in sugar industries.

**Factor 6**: The ‘Cash to current liabilities factor’ explains 7.414% of the variance, contains two variables and has a Cronbach’s alpha of 0.716. These ratios used to determine how quickly we could get cash to meet current liabilities. The usefulness of these ratios is the firm’s ability to service the short-term liabilities. These ratios are the best available test for liquidity position of the firm, an important consideration in productivity management of the sugar industry.

The six financial factors can be further used for investigating productivity in Indian sugar industries using different techniques, which are discussed in the next section.

| Table 2: Variables and Factor Loadings and Component matrix |
|-------------------------------|----------------|----------------|----------------|----------------|----------------|
| **Factors**: Profitability factor (Cronbach’s alpha=0.802) | **Factor 1** | **Factor 2** | **Factor 3** | **Factor 4** | **Factor 5** |
| PAT (NRR) as a % of Net sales | 0.9273 | 0.9256 | 0.8641 | 0.8595 | 0.8053 |
| PAT (NRR) as a % of Gross sales | 0.9256 | 0.8641 | 0.8595 | 0.8053 | 0.7563 |
| PAT (NRR) as a % of Total assets | 0.8641 | 0.8595 | 0.7563 | 0.7320 | 0.5865 |
| PAT (NRR) as a % of Gross fixed Assets | 0.8595 | 0.8053 | 0.7563 | 0.5865 | 0.3855 |
| PAT (NRR) as a % of Net worth | 0.8053 | 0.7563 | 0.5865 | 0.3855 | 0.4000 |
| PAT (NRR) as a % of Capital employed | 0.7563 | 0.5865 | 0.3855 | 0.4000 | 0.4000 |

**Factor 2**: Retained profit factor (Cronbach’s alpha=0.880)

**Factor 3**: Inventory factor (Cronbach’s alpha=0.722)

**Factor 4**: Financial leverage factor (Cronbach’s alpha=0.998)

**Factor 5**: Working Capital factor (Cronbach’s alpha=0.732)

**Factor 6**: Cash to current liabilities factor (Cronbach’s alpha=0.716)
6. Investigating Productivity Using Financial Factors

Using the financial factors obtained from factor analysis, several techniques/methodologies can be used to investigate and manage productivity strategically. Three of the important methodologies are proposed here.

A. Clustering Approach

Simple clustering approach can be used to find the characteristics of the sample firms’ productivity. This method assigns a sample firm to a class by assuming the boundaries between classes are well defined. The firms can be grouped into different patterns.

B. Fuzzy Clustering Approach

Fuzzy clustering approach can also be used to group firms into different patterns. The major advantage of this type of clustering can be used when boundaries are ambiguous in nature. Fuzzy clustering can assign a membership degree to a sample firm to indicate the strength of membership belonging to some class based on the similarity [11]. Statistical models for these patterns can be developed, and the firms of these patterns can recognize the financial factors that are critical to productivity. This can also be used to reveal the competitive status of a pattern in relation to other patterns.

C. System Dynamics Approach

System dynamics model developed using the factors obtained from factor analysis and causalities established through Structural Equation Modelling (SEM) can be used for productivity management in Indian sugar industries. Three-dimensional contour plots are drawn using time dimension on X-axis and financial factors on Y and Z-axis. These plots can be used for analyzing productivity and conclusions can be made on level of the financial factors, which would help in productivity management.

7. Conclusions

Indian sugar industry is facing problems in terms of high and low stocks, poor profitability, mounting cane price arrears etc. Several strategies could be developed and adopted in tandem to combat the situation faced by it. The strategies could be change in government polices economies of the sugar cane plantation and production, decontrol of sugar industry etc. One of the most important strategies that could be adopted by sugar industries is to increase and strategically manage productivity. This strategy of managing and improving productivity can easily be adopted by the sugar industries. The purpose this paper is to study different methodologies to investigate productivity in terms of financial ratios. The study has identified important financial ratios, which have high correlation with productivity, and factor analysis was carried out to get important financial factors. Factor analysis has resulted in six financial factors namely Profitability factor, Retained profits factor, Inventory factor, Financial leverage factor, Working Capital factor and Cash to current liabilities factor. The paper proposed different methodologies that could be used to investigate productivity in terms of financial ratios and they could be the approaches like clustering approach, fuzzy clustering approach and system dynamics modelling etc.

However, this approach is developed specifically for Indian sugar industries. The methodology could be extended to other sectors also.

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