Energy Consumption Behavior of Food and Beverage Industry in India: A State Level Analysis

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Abstract

The Food and beverage industry in India (FBII) is the sunrise sector of our economy. The growth of FBII is enabled and facilitated by an increase in energy intake (Ministry of Food Processing Industry, 2017). This paper tries to analyses the energy efficiency (EE) of the FBII by using energy intensity (EI) for major 15 states during1980-81 to 2017-18. The result reveals that EI varies across the states and it also observed that last few years EI increased for all the states as a result of the growth of FBII. Further, this paper identifies the factors which affect the EI of the FBII and addresses the potential endogeneity problem, applying the Hausman-Taylor Instrumental variables (HT-IV) method for isolating the effects of time-invariant covariates and also to tackle the potential endogeneity problem. This paper found that there exists endogeneity between EE and profit rate. It is found that firm size positively affected EE through profit rate. The present study also found that employees per worker positively influence EE while capital intensity is found to be adversely affected EE. Since degree of mechanization enabled and facilitated by increasing use of energy intake but with expansion of FBII if firms are adopt energy-saving technology that can enhance the energy efficiency. The result also suggests that in order to enhance EE in FBII, policies may be taken which may enhance firm size.

Keywords: *Food and beverage industry, Energy Efficiency, Energy intensity, Endogeneity.*

1. Introduction

Food and Beverage Industry in India (FBII) is widely recognized as a 'sunrise industry' in India. A Rapid change in the consumer segment, market and government policiesare leading to an increase in the growth of FBII (Rais et al, 2013). During the same time, the feature of FBII has undergone a considerable change. The technological bias is highly material and energy-intensive by nature which begets more pollution. The FBII consumes more energy in the various stages of production that involve constant heating, cooling, and at times aerating or brewing. According to the Ministry of Food Processing Industry (MoFPI), inefficient technologies and non-renewable energy sources used to operate FBII causes atmospheric emissions like greenhouse gases including carbon dioxide (MOFPI, 2017). Energy is an essential factor from the viewpoint of both national security and the economy (Soni et al., 2017). Now a day fundamental public policy agenda of India is to enhance the share of India's manufacturing industry to GDP with minimum possible deterioration to the environment, which means efficient use of energy (Mukerjee, 2008), lower fossil fuel dependency, and improved consumer welfare. One of the most impactful sectors of the Indian economy is FBII. It has been identified as a priority sector under "Make in India", an initiative of the Prime Minister of India. The MOFPI, therefore, announced a number of initiatives for expansion of processing capacity, infrastructure, and other supporting initiatives for sustained growth of FBII. Energy is a basic source of growth of output because the production process involves energy as basic input. It is well established that the growth of industrial output and energy consumption are mutually dependent (Eric et al, 2018).The annual growth rate of output of FBII is 8 percent from 2000 to 2018, whereas the average annual growth rate of fuel consumption was 13 % (Calculated based on the various issues of Annual Survey of Industry (ASI)). Along with it, an interstate variation is observed as revealed in terms of the growth rate of energy use in this industry. This growth of fuel consumption is projected to increase further with the expansion of FBII. Therefore the efficient use of energy in different processes of production is a crucial issue for FBII. An efficient energy use reduces the production cost and conserves fuel without reduction in output. Given this background, the pertinent question is whether the rapidly growing FBII used energy efficiently or not? Thus the present paper concentrates on the examination of the energy efficiency (EE)of the FBII which is urgently needed.

There is a wide range of studies dealing with EE in the Indian manufacturing sector by employing different methodologies. Ray and Reddy (2007), Mandal and Madheswaran (2009), Golder (2010), Sahu and Narayanan (2010) Ray (2011), Sahin (2011), Golder (2014), Ghosh and Dutta (2016), Soni et al. (2017),and Sahu and Meheta (2018) analyses EE of Indian manufacturing industries using energy intensity (EI). Ray and Reddy (2007) have analyzed trends in EI of Indian manufacturing during 1992 to 2002. To examine the sources of decline in EI, they have been carried out a decomposition analysis, which helps them to assess the relative sizes of EI effect and structural effect. Based on their results, they conclude that EI declined at the aggregate level during 1992-2002 due to the structural effect rather than the EI effect. Sahu and Narayanan (2010) found both large and small also old manufacturing firms are more energy-intensive. Ray (2011) found EI varied among the seven manufacturing industries and also EI above the average EI of the aggregate manufacturing industries. Sahin (2011) found EI declined over 2005 to 2012; structural changes across firms within industry and across manufacturing industries are the reasons behind this improvement. Golder (2014) analyses the EI of the Indian energy-intensive industry covering the year 1998-99 to 2007-08 and the result reveals EI declined may be due to the substitution of energy for capital, besides there was a large state variation observed after 1992. The study emphasised on scale economics, new entry of firms, and the new investment to reduce EI. Soni et al. (2017) estimated EI and its possible determinants in the cement, aluminum, iron & steel, textile, and fertilizer industry over 2005-14. They found labour intensity has a favorable effect on all sectors and subgroups. Further, the study reveals the impact of plant material intensity is greatest within the top half of the aluminum sector, indicating this industry group's plant expenditures should be reduced. Further, profit after tax intensity had a negative association with in the EI in majority of the sectors; with the top 50% of the fertilizer sector in addition bottom, 50% of the Iron & Steel sector being the most significant. Sahu and Meheta (2018) analysed determinants of emission and EI of Indian manufacturing industries over 2000-14. They found inter firm variation observed and the reasons for variation are firm size and activities of research & development. The study reveals both Larger and smaller firms have more intensive than medium. Mukherjee (2008), Mukherjee (2010), Mandaland Madheswaran (2011), Haider et al. (2019), and Ohlan (2019) analysed EE by using non-parametric approach i.e., data envelopment analysis. Mukherjee (2008) found EE of manufacturing industries varies across states during 1998-99 to 2003-04. The study found the relative price of energy doesn't provide any adequate incentives for saving energy. It also found states with a large percentage share of manufacturing output in energy-intensive industries have lower EE. Furthermore, a higher-quality labour force is linked to greater EE. Mukherjee (2010) found the manufacturing firm could reduce energy input along with it increase output with given technology by an annual average of 3.84% by enhancing technical efficiency. The study suggested to increase output and reduce energy use simultaneously India should use superior technologies that shift efficient frontier outward. Mandal and Madheswaran (2011) analysedthe EE of the Indian cement industry over the year 1989 to 2006. They found enough potential to cut their energy consumption; however, this scope differs among firms. Firms with a high proportion of both qualities of labour and output have higher EE score while, the energy conservation act, 2001 and firm age doesn't have a significant impact. Haider et al. (2019) analysed EE of the Indian iron and steel industry they observed overall average scale efficiency is 0.91and, they conclude that the scale of operation isn't optimum and it has to be altered to improve EE. Ohlan (2019) also analysed EE of the Indian iron and steel industry during 2004-12. The study found this industry has large scope to cut energy use. The study also found larger firms are more energy-efficient and labour productivity positively influenced EE. The literature survey reveals that very few attempts were made on the EE of the FBII. The present study comes in the footsteps of earlier studies in India, but it is different in that it studies the EE of the FBII. Thus, the present study is an endeavor to fill the gap in the existing literature. Given this research gap, the objective of this paper is to analyse the EE of the FBII and along with this, the paper's trying to figure out the important factors that improve the EE of the FBII. The format of the paper is as follows: Section 1.2 discusses the methodology and data source. In subsection 1.2.1 the methodology for Estimation of EE by using the EI technique and for finding out determinants of EE by employing a Panel Approach are discussed. Subsection 1.2.2 discusses data Sources. Sections 1.3 present the results of the analysis elaborately and Summary and Conclusions are made in Section 1.4.

2. Methodology and Data Source

In this section, the methodology for EE estimation by using EI and panel regression techniques for finding out determinants of EE and the data source have been discussed.

2.1 Methodology

The present study uses two-stage methodologies. In the first stage, EE has been estimated separately for sample states employing EI techniques. In the next stage, the factors influencing EE are found out.

2.1.1 Measurement of Energy Efficiency (EE)

Energy Efficiency (EE) improves when less energy inputs with a given output level or level of output increased with given energy input. EI is usually computed as a ratio of energy consumption to output (Farla et al (1998)) and EI is also used to measure EE. The present study used EI to measure EE.EI is a related concept and is an indicator, which shows how efficiently energy is being utilized in a particular economy. Also, it is an important determinant of the projections of future energy demands (Soni et al., 2017). The decline in EI is a proxy for efficiency improvements.
In the present study, EI is defined as energy consumption per unit of output.

$$\mathrm{EI} = \frac{\mathrm{F}}{\mathrm{Y}} \qquad \ldots\ldots\ldots\ldots\ldots \quad \textbf{(1.1)}$$

Where; EI represents energy intensity and F refers to the fuel consumed and Y refers total value of output.

2.1.2 Determinants of the Energy Efficiency (EE)

After calculating EI, in the next stage panel regression has been carried out to find out the determinants of EE of FBII. As declines in EI are a proxy for efficiency improvements, thus the study includes the reciprocal of EI as a dependent variable in this panel retrogression model. This paper studied whether Profit Rate (PR), Capital Intensity (CI), and Employees per Worker (E/L) promote or hinder EE of FBII or not.

The profit of the firms may not be directly associated with the EI of the firms; however, it is indirectly related to the EE (Sahuand Narayanan 2010). It would expect firms with higher PR i.e., profit per unit of output means more efficiently use their resources. The variable CI measured by the ratio of capital to the number of workers is used to capture the degree of mechanization and is expected to facilitate larger operational efficiency. A higher degree of mechanization would be associated with higher EE. However, empirical literature provides an ambiguous relationship between CI and EI. In some cases, capital and energy are substitutes (Sahu et al., 2010) while they are complementary to each other in some other cases. Therefore, the variable CI can influence the EI in both ways i.e., positively or negatively (Mandal and Madheswaran, 2009).This paper also used the variable E/L, which is the ratio of employees other than workers to the number of workers. The variable E/L is used to measure the role of people who aren't directly involved in the production process (Holding clerical or supervisory or managerial positions engaged in the administrative office, store keeping section and welfare section, etc. i.e., employees other than workers).A higher number of E/L generally signifies a higher degree of bureaucratic control within the firm, which can hinder productivity that reduces efficiency but it may be possible employees are operating production efficiently and hence it increases EE.

Since each state has its own characteristics, a state dummy has been introduced for understanding the efficiency of the states. States are grouped into two, namely high output producing states and low output producing states based on all states' average. Those states having average output higher than all states' average are high output producing states and states having average output lower than all states' average are classified as low output producing states.

High output producing states may use more sophisticated technology and have a better managerial skill that may help to produce more output efficiently compared to the low output producing states. Hence it is normally expected that high output producing states are more energy-efficient as compared to the low output producing states.

There are alternative methodologies available in the literature to estimate the panel regression models namely Pooled least square (OLS) model, Fixed Effect Model (FEM) also referred to as the "Least-Squares Dummy Variable (LSDV) model", Random Effect Model (REM), Hausman-Taylor Instrumental variables (HT-IV) model, etc. The present study used the HT-IV model to explore the possible factors influencing EE in FBII.

Hausman and Taylor (1981) suggest a method that mixes the beneficial aspect of both the REM and FEM estimators. The crucial difference between REM and the FEM is based on assumptions about the correlation between individual-specific effects and the set of regressors. HT-IV method is an instrumental variable technique that uses only information that is already in the model to eliminate the correlation between individual-specific effects and error terms. The HT-IV method is an extension of the REM estimators. The main assumption of HT-IV method is that the explanatory variables are correlated with individual effects.

A common problem may be that there may existendogeneity between EE and PR. Because of the potential endogeneity, the present study applying the HT-IV method to isolate the impact of time-invariant covariates and further to tackle the potential endogeneity problem.
Consider a standard panel data model with time-invariant variables in it:

$y_{it} = X_{it} + Z_i\gamma + \mu_i + \in_{it}$.....**(1.2)**

Where, Ziare cross-sectional time-invariant variables. HT-IV splits the covariates into two sets: X = [X_1; X_2] and Z = [Z_1; Z_2] where X_1 and Z_1 are exogenous and X_2 and Z_2 are endogenous and they are correlated with $\mu_i$but not$\in_{it}$. Then we have

$y_{it} = X'_{1it}\beta_1 + X'_{2it}\beta_2 + Z_{1i}\gamma_1 + Z_{2i}\gamma_2 + \mu_i + \in_{it}$.....**(1.3)**

First, we do a "within" transformation, which deducts all the values of variables in the regression from its group mean (individual mean). In that case,Z's would be removed. Therefore we are left with

$\tilde{y}_{it} = \tilde{X}_{1it} + \tilde{X}_{2it} + \tilde{\epsilon}_{it}$ .....**(1.4)**

Where, $\tilde{y}_{it}$ is the "within" transformed y_{it}, etc. From this equation we can estimate the "within" estimator of β_1 and β_2; call them $\hat{\beta}_{1w}$and $\hat{\beta}_{2w}$.

Then we obtain the "within" residual:

$\tilde{d}_{it} = \tilde{y}_{it} - \tilde{X}_{1it}\beta_{1w} - \tilde{X}_{2it}\beta_{2w}$ .....**(1.5)**

The variance of the idiosyncratic error termσ_ϵ^2 can be estimated:

$$\sigma_\epsilon^2 = \frac{RSS}{N-n}.....\textbf{(1.6)}$$

Where, RSS is the residual sum of squares from the within regression.

Now regress $\tilde{d}_{it}$on Z_1 and Z_2, using X_1 and Z_1 as instruments. We get $\hat{\gamma}_{1IV}$and $\hat{\gamma}_{1IV}$, which are consistent estimates of γ_1 and γ_2.

$\gamma_{IV} = (Z'P_AZ)^{-1} + Z'P_A\hat{d}$ .....**(1.7)**

Where $P_A = A(A'A)^{-1}A'$ and A= [X_1, Z_1]

With $\hat{\gamma}_{1IV}$, $\hat{\gamma}_{1IV}$and σ_ϵ^2, we can estimate σ_μ^2(procedure of doing this omitted).

Then define $\hat{\theta}_i$as

$$\hat{\theta}_i = 1 - \left(\frac{\hat{\sigma}_\epsilon^2}{\hat{\sigma}_\epsilon^2 - T_i\hat{\sigma}_\mu^2}\right)^{1/2} .....\textbf{(1.8)}$$

A random effect transformation can be done on each of the variables:

$w_{it}^{*} = w_{it} - \hat{\theta}_i \overline{w}_i$.....**(1.9)**

Where $\overline{w}_i$ is the within-panel mean. That is, each of y, X and Z are transformed in this way. We have now

$$y_{it}^{*} = X_{it}^{*}\beta + Z_{it}^{*}\gamma + \epsilon_{it}^{*} \quad \text{.....(1.10)}$$

Then the H-T estimator can be obtained by IV regression of y_{it}^{*} on X_{it}^{*} and Z_{it}^{*} , with instruments $\tilde{X}_{it}$, $\bar{X}_{1i}$ and Z_{1i}.

The Proposed model for EE is estimated in a panel set up showing a simultaneous relationship between PR.

While estimating the model for each sector various alternatives of the structural equations are tried out and model with the better result are taken.

The models for the EE of FBII are as follows:

For EE, the chosen model considered EE and PR as dependent variables and thus separate equations for each of these variables, i.e. equations 1.11 and 1.12 which are presented below:

$$\left(\frac{1}{EI}\right) = EE = f\left[PR, CI, \frac{E}{L}, DU\right] \quad \text{....(1.11)}$$

$$PR = f\ [EE, CI, FS, DU\ ] \quad \text{....(1.12)}$$

Where, EI stands for Energy Intensity
EE stands for Energy Efficiency
PR stands for profit rate

CI stands for Capital Intensity
$\left(\frac{E}{L}\right)$ stands for Employees per Worker
FS stands for firm size

DU is the state Dummy and is assigned a value of 1 for high average output producing states namely, AP, HA, KA, MH, TN, and UP. This study considered low output producing states namely AS, BH, GU, HP, JK, KE, MP, OR, PU, RA and WB as a benchmark category.

Thus,
DU = 1 for high average output producing states
= 0 otherwise

In **equation 1.11,** time-varying endogenous variable is PR, time-varying exogenous variables are CI, and $\frac{E}{L}$ and time-invariant exogenous variables is DU.

In **equation 1.12,** time-varying endogenous variable is EE, time-varying exogenous variables are FS, and CI, time-invariant exogenous variables is DU.

The specified equations for model of the EE are as under:

$$ln\left(\frac{1}{EI}\right) = ln\ EE = \propto + \beta_{1,it} \ln PR + \beta_{2,it} \ln CI + \beta_{3,it} \ln\left(\frac{E}{L}\right) + \gamma_{1,it} \ln DU + U_{it} \quad \text{......... (1.13)}$$

$Ln\ PR = \propto + \beta_{1,it} \ln EE + \beta_{2,it} \ln FS + \beta_{3,it} \ln CI + \gamma_{4,it} \ln DU + U_{it}$……..…**(1.14)**

The relation between PR and the explanatory variables can be justified as follows:

PR is related with revenue and expenses of the firms, with the increase in EE, a firm can produce more output with the given fuel which may be lowering production costs thus it may increase the firm'sPR.If a firm is larger, it has a higher chance of accessing more resources and is more likely to diversify its product line by taking advantage of economies of scale, resulting in improved profitability(Stierwald, 2010). The variable FS measured by the number of factories.CI measuresa relative degree of mechanization of the production process. High CI signifies a greater degree of mechanization and is expected to facilitate larger operational efficiency thus it increases the firm's profit. However, given the already underutilized capacity, a rise in capital per worker may also affect adverselyon PR. To understand whether the high output producing states have any significant effect on PR compared to the low output producing states, this study considered the state dummy in the PR equation.

2.2 Data Sources

The study uses the secondary time series data for the Indian states collected from the various issues of the Annual Survey of Industries (ASI). Those states are selected for which all the data of inputs and outputs and the determinants are available throughout the sample period. Based on this fact, a sample of the seventeen states namely; Andhra Pradesh (AP), Assam (AS), Bihar (BH), Gujarat (GU), Haryana (HA), Himachal Pradesh (HP), Jammu & Kashmir (JK), Karnataka (KA), Kerala (KE), Madhya Pradesh (MP), Maharashtra (MH), Orissa (OR), Punjab (PU), Rajasthan (RA), Tamil Nadu (TN), Uttar Pradesh (UP), and West Bengal (WB) selected over the period 1980-81 to 2017-18.

Data on the variables like fuel consumption, gross value added (GVA), employees, number of workers, number of factories, and gross fixed capital formation over the period 1980-81 to 2017-18 have been used. All the data have been collected from various issues of ASI published by the Central Statistical Organization, Ministry of Statistics and Programme Implementation, GOI, New Delhi. Data of employees other than works is obtained by subtracting no. of workers from employees.

All the nominal values are deflated by the appropriate wholesale price index; to obtain their real values i.e. GVA is deflated by the price index of FBII, fuel consumption by the price index of fuel power light, and lubricant of FBII. The data on capital stock (K) have been obtained by the Perpetual Inventory Accumulation Method[20]. Relevant Price indices are collected from the Index Number of Wholesale Prices in India published by the Office of the

[20]Let B_t denote the book value of fixed assets at the end of year t, $D_t$the depreciation allowances made in that year and P_t the capital goods price index i.e. machinery and equipment index for that year. Then the series on real fixed investment may be derived as

$$I_T = \left(\frac{B_T - B_{T-1} + D_T}{P_T}\right)$$

Then the K series can be derived by using the following relationship:

$K_T = K_{T-1} + I_T$ ……….. (a)

or $K_T = K_0 + \sum_T I_T$ ……..…. (b)

Where $K_0$is an estimate of real capital stock for a benchmark year. It has been taken at 2004-05. $B_t$istaken as gross fixed capital formation. The present paper has used expression (b) to generate the K series.

Economic Advisor, Ministry of Industry, GoI, UdyogBhaban, New Delhi.2004-05 is taken as the base year for the calculation of the price index.

3. Results of Analysis

3.1 Estimated Results of Energy Intensity (EI)

In this section, the results of EI of the FBII in different major states are discussed.

The result of EI showed fluctuating for all the states over the entire period. Hence to get a complete idea about the states' performance first, simple arithmetic mean (A.M.), standard deviation (S.D.), and coefficient of variation (CoV) of EI for each state throughout the sample period (1980-81 to 2017-18) and also grand A.M. (mean of A.M.s), grand SD (mean of S.D.s) and grand CoV (Mean of CoVs) have been computed and thereafter compare A.M., S.D. and CoV with grand A.M., grand S.D. and grand CoV (**Table 2**).

High A.M. implies high average EI which means energy consumption per unit of output is high, which is undesirable. However, high values of S.D. and CoV imply fluctuation of EI. Here the study classified the level of performance under three heads:

Good performer: Low A.M., Low S.D., Low CoV

Bad performer: High A.M., Low S.D., low CoV or High A.M., High S.D., Low CoV

Medium Performer: Low A.M., Low S.D., High CoV or High A.M., High S.D., High CoV.

The result reveals that three states namely; KA, MH, and UP are good performing states having low A.M., low S.D. and low CoV as compared to the grand A.M. grand S.D. and grand CoV. This implies that consistently low EI observe over the entire time period. This means that these three states are more energy-efficient states as compare to the other fourteen sample states. Nine states namely; AP, AS, BH, HA, JK, MP, OR, RA and WB are bad performing states. Among them the three states; AP, AS and RA have high A.M., low S.D., and low CoV as compared to the grand A.M. grand S.D., and grand CoV. This indicates that consistently high EI observed over the entire period which is undesirable. The remaining six states, BH, HA, JK, MP, OR, and WB have high A.M., high S.D., and low CoV. This indicates over the entire period high EI is observed and low CoV reflect that continuously high EI observed during the sample period further it is undesirable. Five sample states, GU, HP, KE, PU, and TN are medium performing states. Among them, three states; GU, HP, and KE have high A.M., high S.D., and high CoV as compared to the grand A.M. grand S.D., and grand CoV. This indicates consistently high EI observed over the entire period again it is undesirable. The remaining two medium performing states; PU and TN have low A.M., low S.D., and high CoV. This indicates that although low average EI is observed throughout the entire period but as CoVis high for those states it indicates that EI highly fluctuating, similarly that's not desirable.

Table 1: Estimated Value of A.M., S.D. and CoVof EI for the sample states

Name of the Sates	A.M.	S.D.	CoV
AP	1.19	0.77	0.65
AS	1.16	0.80	0.69
BH	1.30	1.18	0.91
GU	0.95	1.07	1.13

HA	1.20	1.22	1.01
HP	1.23	1.17	1.40
JK	1.25	0.89	0.57
KA	0.52	0.52	1.01
KE	1.32	3.45	2.62
MH	0.73	0.71	0.96
MP	1.41	1.41	1.01
OR	1.73	1.52	0.88
PU	0.55	0.66	1.21
RA	1.25	1.15	0.92
TN	0.50	0.57	1.15
UP	0.96	1.00	1.04
WB	1.32	1.53	1.16

Source: Compiled by the Author.

Table 2: Comparison of A.M., S.D. and CoV of EI for the major states with the grand A.M., S.D. and CoV

Name of the Sates	A.M.	S.D.	CoV	Performance
AP	High	Low	Low	Bad
AS	High	Low	Low	Bad
BH	High	high	low	Bad
GU	Low	Low	High	Medium
HA	High	High	Low	Bad
HP	High	High	High	Medium
JK	High	Low	Low	Bad
KA	Low	Low	Low	Good
KE	High	High	High	Medium
MH	Low	Low	Low	Good
MP	High	High	Low	Bad
OR	High	High	Low	Bad
PU	Low	Low	High	Medium
RA	High	Low	Low	Bad
TN	low	low	High	Medium
UP	Low	Low	Low	Good
WB	High	High	Low	Bad

Source: Compiled by the Author.

Along with it, the study estimated the compound annual growth rate (CAGR) of EI. The total sample years is divided into four sub-period; the first sub-period covers the year 1980-81 to1989-90, the second sub-period cover 1990-91 to 1999-00, the third sub-period cover 2000-01 to 2009-10 and the fourth sub-period cover the year 2010-11 to 2017-18. The result is shown in **Table 3**.

The result reveals the following: CAGR of EI is positive and continuously increased for the states BH and JK. The CAGR of EI in the second sub-period is 2% and it increases by 3 %

and 4 % in the third and fourth sub-period respectively. CAGR of EI for JK is 1% in the second sub-period and it increases by 2% and 3% third and fourth sub-period respectively. The CAGR of EI after the third sub-period (2000-01 to 2010-11) is positive and increases for 9 states namely; AS, GU, HA, HP, MP, PU, RA, UP, and WB. CAGR of AS is 2% and 5 % in the third and fourth sub-period respectively. In the third sub-period the CAGR of GU is 1% and it is increased by 3% fourth sub-periods. For the state HA, the CAGR of EI is 3 percent and it increases by 8% in fourth sub-period. The CAGR of HP is 1% in the third sub-period and it increases by 4% in the fourth sub-period i.e., 2010-11 to 2017-18. For MP, the CAGR of EI is 2% and 7% in the third and fourth sub-period respectively. For PU, the CAGR of EI is negative for the third sub-period and it increased by 9% in the fourth sub-period. For RA, CAGR is 1% and 10% observed in the third and fourth sub–period respectively. For the state UP, CAGR is 0.02 and 0.18 observed in the third and fourth sub – period respectively and for the WB; CAGR of EI is negative for the first and second sub-period. However CAGR is 0.05 and 0.17 observed in the third and fourth sub–period respectively. CAGR of EI is positive in the fourth sub-period for the six state namely, AP, KA, KE, MH, OR, and TN. The CAGR of EI is 2%, 1%, 4%, 4%, 4%, and 2% observed for the states; AP, KA, KE, MH, OR, and TN respectively.

Table 3: Compound annual growth rate of EI of FBII for the sample states

Name of the States	*Sub Period 1 (1980-1990)*	*Sub Period 2 (1990-2000)*	*Sub Period 3 (2000-2010)*	*Sub Period 4 (2010-2017)*	**Total Period** *(1980-2017)*
AP	0.09	-0.03	-0.06	0.02	0.01
AS	-0.01	-0.15	0.02	0.05	0.01
BH	0.00	0.02	0.03	0.04	0.04
GU	-0.02	-0.72	0.01	0.03	0.03
HA	-0.02	-0.12	0.03	0.08	0.04
HP	-0.01	-0.02	0.01	0.04	0.03
JK	0.00	0.01	0.01	0.03	0.02
KA	-0.01	-0.20	-0.23	0.01	0.01
KE	-0.20	-0.12	-0.06	0.04	0.08
MH	-0.14	-0.09	-0.05	0.04	0.02
MP	-0.06	-0.01	0.02	0.07	0.03
OR	0.01	0.00	-0.01	0.04	0.02
PU	-0.13	-0.17	0.03	0.09	0.03
RA	-0.04	-0.01	0.01	0.10	0.02
TN	0.00	-0.14	-0.02	0.02	0.02
UP	-0.15	-0.27	0.02	0.08	0.03
WB	-0.30	-0.03	0.05	0.17	0.03

Source:Compiled by the Author.

3.2 Results of Determinants of Energy Efficiency:

To identify factors that influence EE a panel regression analysis was conducted. The present study used the reciprocal of EI as a proxy measure of EE.

A common issue may be that there may existendogeneity between EE and PR. Because of the potential endogeneity, the present study applies the HT-IV method to isolate the impact of time-invariant covariates and to tackle the potential endogeneity problem.

The result of the determinants analysis of EE is presented in **Table 4**. The estimated model also reports 'rho' which indicates the overall fit of the model, a high value of 'rho' represent the fitted model is reasonably good.

To determine the factors that influence EE, the study considers the variables like Profit Rate (PR), Capital Intensity (CI), and Employees per Worker (E/L).

The result of the determinants of EE reveals that EE is positively related to PR. The reason may be higher PR means firms minimize their production cost by efficiently use of their resources during the production process (Sahu and Narayan, 2010).

A negative association is found between CI and EE implying that with higher degree of mechanization the firms are more energy-intensive and less energy efficient. This result is tune with Papadogonas et al (2007) which reveals that capital-intensive firms are too energy intensives.

A positive association found between E/L and EE. This positive relation can be obtained between E/L and efficiency if the combination of the workforce is just right to operate the production process efficiently.

A positive and significant association found between the state dummy and EE which implies that high output producing states are more energy efficient compared to the low output producing states.

Table 4: Determinants of Energy Efficiency of FBII

Variables	**Coefficient**	**Z**	**P>Z**
C	9.28	38.37	0
Time Varing Endogenous Variables			
PR	0.16	12.56	0
Time Varing Exogenous Variables			
CI	-0.76	-2.80	0
$\left(\frac{E}{L}\right)$	0.97	53.07	0
Time Inveriernt exogenous variables			
DU	0.71	38.37	0.01
Wald Chi 2	5756.6		
Prob> Chi 2	0		
rho	0.73		

The result of the determinants analysis of PR is presented in **Table 5**. It may be mentioned that a non-linear estimated equation is to be found. Thus the sign of marginal effects will help to assess the positive or negative relationship for those variables which are nonlinearly related with dependent variable in the equation. The marginal effect of the explanatory variables and the statistical significance of these variables have been checked by the Wald test, presented in **Table 6.**

The result of determinants of PR reveals that EE is positively associated with PR. This implies with an increase in EE firm produce can produce more output with the given fuel which may diminish the production cost thus it may increase the firm's profit.

A positive and significant associationfound between PR and CI. That may be because a higher degree of mechanization facilitates larger operational efficiency thus it increasesthe firm's profitability.

An inverted 'U'- shaped association found between the PR and FS. That means FS increases PR but up to a certain level, further increasing the FS leads to reduce the PR. The reason may be that larger firms have greater capability to diversify their business and exploit economies of scale and scope. By making their operations more effective, these characteristics help them generate superior performance relative to the smaller ones (Penrose, 1959) but after the threshold limit since the size is correlated with market power (Shepherd, 1986) and market power helps to develop X-inefficiencies (Leibenstein, 1976), hence increase in FS may have an adverse effect on EE. The marginal effect of FS is positive implies FS influence EE through PR.

A positive and significant association found between DU and PR implies that the PR is more in high output producing states compared to the low output producing states.

Table 5: Determinants of Profit Rate of FBII

Variables	Coefficient	Z	P>Z
C	0.31	5.12	0
Time Varing Endogenous Variables			
EE	0.02	5.82	0
Time Varing Exogenous Variables			
CI	0.01	7.13	0
FS	0.05	8.17	0
FS^2	-0.04	-6.03	0
Time Inveriernt exogenous variables			
DU	0.05	2.26	0.02
Wald Chi 2	354.33		
Prob> Chi 2	0		
rho	0.49		

Table 6: Marginal Effects of the Determinants of Profit Rate

Variables	Marginal Effect	Chi-square
Firm Size	1.68	11.48*

**** Significant at 1% level, ** Significant at 5% level, ***Significant at 10% level.***

4. Summary and Conclusion

The present study deals with the analyses of the energy efficiency (EE) of the food beverage industry in India (FBII) for the seventeen major selected Indian states namely; Andhra Pradesh (AP), Assam (AS), Bihar (BH), Gujarat (GU), Haryana (HA), Himachal Pradesh (HP), Jammu & Kashmir (JK), Karnataka (KA), Kerala (KE), Madhya Pradesh (MP), Maharashtra (MH), Orissa (OR), Punjab (PU), Rajasthan (RA), Tamil Nadu (TN), Uttar Pradesh (UP), and West Bengal (WB) employing energy intensity (EI) over 1980-81 to 2017-18. The study also identifies the influencing factors of EE to obtain a comprehensive picture of the possible determinants; a panel regression analysis was conducted.

The major findings of the study can be summarized as follows:

First, the EI of some of the sample states showed a fluctuating pattern over the entire time period. For this, to get a complete idea about the states' performance in respect of EE compare arithmetic mean (A.M.), standard deviation (SD), and coefficient of variation (CoV) with grand A.M., grand SD, and Grand CoV. The result reveals three states; KA, MH, and UP are good performing states in terms of EE. The five states; GU, HP, KE, PU, and TN are medium performing states furthermore rest of the other nine states; AP, AS, BH, HA, JK, MP, OR, RA, and WB are bad performing states.

Secondly, the result reveals that the CAGR of EI is positive and continuously increased for the states BH and JK. The CAGR of EI after the third sub-period (2000-01 to 2010-11) is positive and increased for 9 states namely; AS, GU, HA, HP, MP, PU, RA, UP, and WB. CAGR of EI is positive in the fourth sub-period for the 6 states namely, AP, KA, KE, MH, OR, and TN.

Lastly, the result of determinants of EE reveals that EE is positively related with PR. The reason may be higher PR means firms minimize their production cost by efficiently use of their resources during the production process (Sahu and Narayan, 2010).

A negative association is found between CI and EE implying that capital-intensive firms are too energy intensives (Papadogonas et al. (2007)).

A positive association found between E/L and EE. This positive relationship can be obtained between E/L and efficiency if the combination of workforce is just right to operate the production process efficiently.

A positive and significant association found between state dummy and EE which implies that high output producing states are more energy efficient compared to the low output producing states.

Since degree of mechanization enabled and facilitated by increasing use of energy intake but with expansion of FBII if firms are adopt energy-saving technology that can enhance the energy efficiency. The present paper also suggests that in order to enhance EE in FBII, policies may be taken which may enhance firm size.

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