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Efficiency and Productivity Changes in the Indian Food Processing Industry: Determinants and Policy Implications

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Abstract

This paper analyses efficiency and productivity changes in 12 broad segments of food manufacturing industries during pre and post liberalisation periods, covering a period of two decades, from 1980-1981 to 2001-2002. The nonparametric Data Envelopment Analysis (DEA) approach is used to compute the Malmquist Total Factor Productivity (TFP) change, which has been further decomposed into efficiency and technical change. This paper also evaluates the performance of major inputs used in the food processing industry and identifies the causes of inefficiency across various segments. Based on the findings, the paper gives suggestions that can be used by policy makers and food processors in making decisions regarding various technical and managerial aspects to improve productivity and efficiency.

Keywords: Technical Efficiency, Total Factor Productivity (TFP), Food Processing, Data Envelopment Analysis (DEA), India.

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Introduction

The food and agricultural sectors in developing countries have been significantly transformed in the way food is produced, processed, marketed and consumed (Busch and Bain 2004; Deshingkar el al. 2003; Henson and Reardon 2005; Pinstrup-Andersen 2000; Reardon el al. 2001; Swinnen and Maertens 2007). Consumers have also been responding to changes in quality of food intake and are becoming more conscious regarding nutrition, health, and food safety issues (FAO 2003; Deininger and Sur 2007). Historically, Indian consumers have preferred fresh and unprocessed food over processed and packaged food; however, the recent changes in consumption patterns, particularly in middle and high income groups, show ample opportunity for processed food segments in the country (Bhalla and Hazell 1998; Bhalla, Hazell, and Kerr 1999; Chand 2003; Chenggapa et al 2005; Deininger and Sur 2007; Kumar 1998; Mukherjee and Patel 2005). Rising income, increased urbanization, changing lifestyle, greater willingness to experiment with new products and flavours, desire for convenience and an increase in the number of working women have led to a strong growth in consumption of packaged and processed food products (Goyal and Singh 2007).

The process of economic liberalisation in India has been on its way since the late 1970s and early 1980s, but at a slow and halting pace (Gulati and Chadha 1993). The first comprehensive economic reform policy statement was formulated for India in July 1991 in the form of industrial and trade sector liberalisation (Ganguly-Scrase and Scrase 2001). The economic reforms of the 1990s, which strengthened the process of liberalisation, privatisation and globalisation in the country, have brought new opportunities and challenges before food processors through a competitive market environment. To meet the emerging demand for processed food products, both national and multinational food processing organizations have been trying to capture the huge and exponentially growing food market by adopting sophisticated technologies to facilitate innovations in food product development and packaging for competitive success and survival within the consumer market across the world (Bogue 2001; Stewart-Knox and Mitchell 2003 Wells, Farley, and Armstrong 2007). The capital investment in the food processing sector has significantly increased after the economic reforms of 1991 in the country. The government has also relaxed the restrictions on technology imports and private foreign direct investment to strengthen the manufacturing sector, including food processing (Goyal 1994; Vachani 1997; Bowonder 1998; Gandhi, Kumar, and Marsh 2001; Athreye and Kapur 2001; Das 2003; Mani 2004). Rodrik and Subramanian (2004) categorise the reforms of 1980s and 1990s as “pro-business” and “pro-market”, respectively. The eighties’ reforms focused on increasing the profitability of existing firms by easing capacity restrictions and reducing corporate taxes, while the reforms of the nineties allowed more competition and increased provisions for the entry of new domestic firms and multi-national companies (MNCs) in the Indian manufacturing sector. Therefore, analysing productivity and efficiency changes across the manufacturing sector during pre and post reform periods becomes essential for providing strategic inputs to the producers, the government and other stakeholders.

Market liberalisation is expected to have a favourable impact on productivity growth in the manufacturing sector due to several reasons. Krishina and Mitra (1998) argue that trade can spur innovation by enhancing industrial learning, exchange of technical information, sharing of global research and elimination of duplication in research and development. Goldar and Kumari (2003) have listed several expected impacts of import liberalisation on productivity and efficiency of manufacturing sector: (i) import liberalisation will provide the industrial firms with greater and cheaper access to imported capital goods and intermediate goods; (ii) greater availability of imported capital and intermediate goods will enable the firms to enhance the productivity and efficiency in a better way; (iii) the increased competition among manufacturing units will enforce better utilisation of resources; (iv) the increased competitive pressure coupled with expanded opportunities for importing technology and capital goods will bring greater technological dynamism in industrial firms; (v) since competitive business environment forces inefficient firms to close down, the average level of efficiency of various industries should improve; and (vi) greater access to imported inputs and a more realistic exchange rate associated with a liberalized trade regime would enable manufacturing firms to compete more effectively in export markets. Similarly, other researchers emphasise that trade reforms lead to increased international competition which brings about a reduction in input slacks and greater access to a variety of specialised inputs for enhancing production efficiency (Chand and Sen 2002; Horn, Lang, and Lundgren 1996). Pattnayak and Thangavelu (2005) indicate that key elements of the New Industrial Policy (NIP) of 1991 aim at enhancing productivity and efficiency in the Indian manufacturing sector by increasing competition, creating a level playing field among public, private and foreign businesses, and generating a conducive environment for technological growth through abolition of licensing, reducing the reserved list for public sector undertakings, increasing foreign equity ownership and investment, promoting private investment in infrastructure, allowing free import of capital goods, reducing tariffs for consumer goods and deregulating small scale units. However, there are contrasting views as well on the linkage of market liberalisation with productivity and efficiency growth. The traditional infant industry argument, which has greater relevance to the Indian food processing sector, emphasises that the removal of protection through market liberalisation may force the majority of small and medium firms to close down their business (Driffield and Kambhampatti 2003).

There are very few empirical evidences regarding the contribution of technology to the growth of the food processing industry at the disaggregated level. However, evidences from the food industry as a whole during different periods of time indicate varied contributions of technology to the growth of the food processing industry. The average growth of Total Factor Productivity (TFP) in Indian manufacturing was sluggish during 1951-1979 and the relative contribution of TFPG to output growth was meagre (Goldar 1986). There was negative TFP growth in Indian food processing during 1959-1986 (Ahluwalia 1991). Mitra, Varoudakis, and Vegarzones (1998) analysed the impact of available infrastructural facilities on Total Factor Productivity Growth (TFPG) and Technical Efficiency (TE) in Indian manufacturing and estimated positive TFPG in food processing during 1976-1992. Other empirical analysis also show mixed TFPG in organized food processing sector (Balakrishanan and Pushpangadan 1994; Mitra 1999; Trivedi, Parkash, and Sinate 2000; Goldar and Kumari 2002; Pattnayak and Thangavelu 2005).

Several empirical studies have also analysed the relationship of India's economic reforms and market liberalisation initiated in the year 1991 with competition and productivity growth in the manufacturing sector (Srivastava 1996; Joshi and Little 1997; Krishna and Mitra 1998; Forbes 2001; Hasan 2002; Rani and Unni 2004). Empirical evidences show that the economic liberalisation has positively promoted total factor productivity in the Indian manufacturing sector (Goldar 1986; Ahluwalia 1991; Chand and Sen 2002; Driffield and Kambhampatti 2003; Milner, Vencapa, and Wright 2007). Some studies also indicate a negative impact of liberalisation on productivity growth in various manufacturing sub-sectors (Balakrishnan, Pushpangadan, and Babu 2000; Singh, Coelli, and Fleming 2000; Srivastava 2001; Das 2003).

The food processing sector in India covers a wide range of food items such as meat and meat products, fish and fish products, fruits and vegetables, vegetable oils and fats, milk and milk products, grain milling, animal feed, confectionery products, bakery products, sugar processing, among others. The level and structure of the Indian food processing industry reflects that food production is mainly constrained due to lack of productivity augmenting technologies. To meet the emerging challenges, there is an urgent need to bring efficiency to the production process, either through maximizing the output or minimizing the cost. Therefore, technology is the key to improvement in the growth and efficiency of the food processing sector. This study evaluates the performance of various segments of the food processing industry in India in terms of TFP and efficiency change over the period of 1980-1981 to 2001-2002, to analyze pre and post market liberalisation situations. Using the Malmquist productivity index, this study decomposes the TFP change in the disaggregated food processing sector into technical and efficiency changes. The study empirically analyses the determinants of productivity change and reasons for inefficiency in the production process, which consequently indicate practical policy directions for strengthening and accelerating the growth of various sub-segments of the industry. In particular, the study intends to find the answers to the following questions and compare the pre and post market liberalisation periods:

- Are there structural changes across the food processing sector with respect to number of manufacturing units, employment generation, capital investment and gross value added (GVA)?
- Has the performance of the food processing industry in India improved since the market liberalisation of the 1990s in terms of productivity and efficiency changes?
- What are the major factors causing production inefficiencies, and what are the possible solutions for addressing these issues across the food processing sector?

This study expects to identify the emerging segments of the food processing sector during post market liberalisation period, which may become potential investment avenues for food processors. The structural change in food consumption patterns towards high-value products such as fruits, vegetables, milk, meat and eggs may provide greater opportunity to these units for growth and development. It is expected that these segments will invite and encourage more entrants and investments during the market liberalisation period to meet the growing demand. Because of this, capital investment in high-value food segment is expected to increase at a higher rate than others. The efficiency and productivity changes are expected to be low due to the long gestation of capital investment, which should increase in the years to come. The study also expects to analyze the factors causing inefficiency and low productivity across the food processing sector, which will provide implications for food processors as well as policy makers in addressing critical issues to strengthen sustainable growth and development. This will also facilitate in deciding the optimal mix of factor inputs and modernisation of production process for better efficiency and productivity.

Data and Methodology

The data on input and output related to registered/organized food manufacturing units has been compiled for the period of 1980-1981 to 2001-2002 from the Annual Survey of Industries published by the Central Statistical Organization (CSO), Ministry of Statistics and Programme Implementation, Government of India. The data on value of output and inputs of food processing units has been converted into constant prices, considering 1993-1994 as the base year by using the appropriate price indices of the respective commodity groups and inputs. All units with 50 or more workers operating with power, and units having 100 or more workers operating without power were covered under the CSO database. A brief definition of variables used for estimating TFP and efficiency change is given in Box 1. The Data Envelopment Analysis (DEA) Approach is used for measuring productivity change and efficiency in the Indian food processing industry over the period of 1980-1981 to 2001-2002, with categorisation of data into pre reform period (1980-1981 to 1990-1991) and post reform period (1991-1992 to 2001-2002). About two decadal panel data has been used to capture the fairly long-term effects of the pre and post market liberalisation periods on productivity and efficiency, and also to assess the structural changes in the food processing industry. As the major economic reforms in the country took place during the 1990s, a comparison of productivity and efficiency between pre and post reform periods across the food processing sector provides practical insights on technical and managerial issues for policy makers, food processors and researchers in the changing market environment. Data Envelopment Analysis (DEA) is the most commonly used nonparametric method across the world for estimating relative efficiency with reference to best practice frontier (Cooper, Sinha, and Sullivan 1996; Jayanthi, Kocha, and Sinha, 1999; Emrouznejad, Parker, and Tavares 2008). The advantage of using the DEA-based Malmquist index is that the estimation of the production frontier requires fewer observations and assumptions as compared to parametric methods such as stochastic frontier estimation (Mao and Koo, 1997; Zheng, Liu, and Bigsten 2003). This method does not require specification of the underlying technology and has an advantage in dealing with disaggregated input and output variables. However, the parametric methods were questioned by many economists because of the limitation of chosen functional forms, biased estimates in the presence of measurement error, lack of statistical fit and dependency on the choice of variables (Arnade 1994; Mao and Koo 1997; Donthu, Hershberger, and Osmonbekov 2005; Ruggiero 2007).

Box 1: Variable Definitions

Output: Gross output is defined as the ex-factory value of products and by-products manufactured during the accounting year.

Cost of Capital: User's cost of capital; i.e., a sum of depreciation, interest payment and rent is used to estimate the capital use in food processing industry

Labour: The annual survey of the industry provides two categories of labour employment in the food processing industry, i.e., employees and workers. The data available on number and payment to employees and workers is used in the study.

Raw Material: Raw material is the major input used in food processing, basically constituting raw agricultural produce of respective food unit, like food, spices, edible oils, vegetables, chemicals, ice and packing materials, etc.

Energy Used: Values/costs of different types of energy; mainly includes electricity, diesel and petrol used in food processing units.

The DEA methodology was initiated by Charnes, Cooper, and Rhodes (1978) whose work was largely based on the frontier concept pioneered by Farrell (1957). Thus, the DEA is a methodology directed to frontiers rather than central tendencies

(Seiford and Thral 1990). This method attempts to measure the efficiency of Decision Making Units (DMUs)/firms through linear programming techniques which "envelop" observed input–output vectors as tightly as possible (Boussofiane, Dyson, and Thanassoulis 1991). The original model developed by Charnes, Cooper and Rhodes (CCR model) was applicable when technologies were characterized by constant returns to scale (CRS) and all firms operated at an optimal scale (Coelli, Prasada, and Battese 1998). But, imperfect competition may cause a DMU not to operate at optimal scale (Coelli 1996). Therefore, an input-oriented variable return to scale (VRS) Data Envelopment Analysis Model extended by Banker, Charnes, and Cooper (BCC Model) in 1984 has been used for measuring technical and scale efficiency.

For estimating the TFP change in the Indian food processing industry, the Malmquist productivity index is used. The Malmquist productivity index was introduced by Caves, Christensen, and Diewert (1982) based on the distance functions developed by Malmquist, which is defined as the ratio of two output distance functions. In other words, the Malmquist TFP index measures the TFP change between two data points by calculating the ratio of the distances of each data point relative to a common technology. The input-output variables used in this study include cost of capital, labor, raw material consumed, energy used and gross value of output. The Malmquist TFP index and efficiency scores have been obtained by using the Data Envelopment Analysis Program (DEAP) software (version 2.1) developed by Coelli (1996).

Results and Discussion

Performance of Food Processing in India

Food processing is an emerging sector of Indian economy and is growing at a rate of more than 10 percent per annum. The majority of the food processing units in the country are unorganized and are facing various kinds of challenges in the fast changing global scenario. The analysis of structural changes in food processing units suggest that in terms of number of units, the change in composition is significantly visible in the case of grain milling, which has increased from 13.3 percent during the pre-liberalisation period to 20.0 percent during the post liberalisation period (Table 1). The share of all other types of food processing units, in terms of number of units, has increased over time, except sugar & jaggery and vegetable oils. Processing units under these categories have closed down due to unfavorable policy environment and increased competition after market liberalisation. The food processing units summarized in the "Other Food Items" category constitute 30.4 percent of total units, which include manufacturing of macaroni, noodles and similar products; processing and blending of tea; coffee curing, roasting, grinding and blending; processing of edible nuts; manufacturing of malted foods; grinding and processing of spices; manufacturing of *papads,* appalam and similar products; and manufacturing of vitaminised high protein food products and other semi-processed, processed or instant foods not included below.

Table 1: Structural Composition of Indian Food Processing Industry (%)

Group	Number of Factories			Employment (No.)			Gross Value Added (Rs. Lakh)		
	1980-1982	1991-1992	1999-2001	1980-1982	1990-1992	1999-2001	1980-1982	1990-1992	1999-2001
Meat / Meat Products	0.3	0.3	0.5	0.8	0.6	0.7	0.7	0.6	1.2
Fish / Fish Products	0.9	1.5	2.5	1.1	1.2	2.1	1.4	1.6	2.8
Fruits / Vegetables	0.9	1.3	2.0	1.0	1.1	1.7	0.7	0.9	2.1
Vegetable Oils	8.1	9.1	7.9	10.3	9.6	7.5	24.8	28.8	20.3
Dairy / Dairy Products	2.4	4.4	5.7	8.2	11.3	13.8	10.4	11.1	13.5
Grain Milling	13.3	20.0	23.4	12.5	10.5	11.6	10.0	13.4	18.8
Starches / Starch Products	0.7	1.0	1.4	1.0	0.9	1.6	3.4	3.1	4.3
Animal Feeds	0.4	0.9	1.5	0.8	1.4	2.1	0.7	1.3	2.3
Bakery Products	1.6	2.9	3.5	3.6	4.3	4.5	2.9	3.5	4.2
Sugar Indigenous / Refined	44.3	29.6	20.1	42.4	45.1	37.4	21.7	17.2	10.9
Confectionery	0.3	0.7	1.0	0.5	0.9	1.9	0.4	0.8	1.6
Other Food Items	26.9	28.2	30.4	17.7	13.1	15.2	23.1	17.8	18.1
Food Industry	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Annual Survey of Industries (various issues), CSO, New Delhi

Food processing is an important employment generating segment within the agriculture sector in India and has a vast scope for its development (Gupta 2002; Rani and Unni 2004). The distribution of employment in different types of food processing units shows that sugar & jaggery employs 37.4 percent persons out of the total employed (Table 1), followed by dairy and dairy products (13.8%) and grain milling (11.6%). Per unit labour absorption capacity of sugar & jaggery segment is high, which employed 258 persons in 1999-2001 (Table 2). Animal based industries such as meat, dairy and fishery processing units are also labour intensive, employing 112, 111 and 109 persons, respectively, per unit on an average during the same period.

The composition of the gross value added (GVA) shows that vegetable oil units constitute the major share (20.3%), followed by grain milling (18.8%), dairy and dairy products (13.5%), and sugar and jaggery (10.9%). Gross value added per unit is highest in sugar and jaggery units followed by meat and meat products, dairy products, and confectionery (Table 2). Moreover, capital investment has increased positively in all segments of the food processing industry but is comparatively high in case of sugar & jaggery and meat & meat products. Per unit capital investment in sugar and jaggery units has drastically increased in recent years for making these units more viable and sustainable through productivity & efficiency improvement and increased utilisation of the by-products. The capital investment in meat and meat products has also increased to meet the emerging export demand (Table 2).

Table 2: Employment, Capital and Gross Value Added in Indian Food Processing (Per Unit)

Group	Number of Person Employed			Cost of Capital Rs. lakhs			Gross Value Added Rs. lakhs		
	1980-1982	1990-1992	1999-2001	1980-1982	1990-1992	1999-2001	1980-1982	1990-1992	1999-2001
Meat / Meat Products	139	109	112	14.19	34.51	107.14	34.0	94.7	208.3
Fish / Fish Products	50	81	109	4.60	17.58	42.43	8.8	54.2	72.4
Fruits / Vegetables	71	68	54	4.01	10.21	26.09	7.3	21.1	49.8
Vegetable Oils	32	33	37	2.69	10.29	19.71	7.6	21.9	44.7
Dairy / Dairy Products	142	131	111	11.96	28.27	53.12	34.4	76.7	182.7
Grain Milling	23	22	25	1.08	2.74	5.67	2.6	5.6	12.5
Starches / Starch Products	25	31	25	2.41	7.45	15.75	6.6	13.0	29.6
Animal Feeds	37	43	45	3.20	7.15	17.29	11.4	29.4	46.3
Bakery Products	39	44	47	1.82	5.28	9.03	9.3	24.3	48.6
Sugar Indigenous / Refined	247	259	258	13.02	65.11	228.42	23.7	108.9	323.3
Confectionery	40	62	52	2.53	14.21	29.17	9.2	45.8	115.3
Other Food Items	108	89	94	2.23	6.59	12.47	11.4	34.5	48.5
Food Industry	73	56	54	3.54	10.05	22.77	8.9	23.8	48.7

Source: Annual Survey of Industries (various issues), CSO, New Delhi

The annual growth performance of the food processing industry in terms of number of units, employment and the gross value added (GVA) during the pre and post reform periods is given in Table 3. It is clear from the table that the high value segments, such as meat and meat products, fish and fish products, fruits and vegetables, milk and milk products, starches and starch products and confectionery, have significantly gained in terms of number of units, employment, investment and output growth during the post-reform period. Maximum growth in number of units during the post-liberalisation period has been experienced by starches and starch products followed by fruits and vegetables. The number of persons employed in food processing units has also increased positively across the sector during the post-liberalisation period. There has been positive growth in employment during the post-liberalisation period as compared to negative growth during the pre-market liberalisation situation.

Value addition across the food processing industry in the country has been growing at a very significant rate over the last two decades (Table 3). The rate of growth in the gross value added of the food processing industry was 11.74 percent during 1980-1990 (pre reform period), which has slightly declined during 1990-2001 (post reform period) but is still higher at 9.23 percent. However, the growth in value addition increased during the 1990s for most of the high-value food processing

Table 3: Growth Performance of Food Processing Units in India, 1980-2001 (%)

Group	Number of Units			Number of Person Employed			GVA (Rs. in lakhs at 1993-94 prices)		
	1980-1990	1990-2001	1980-2001	1980-1990	1990-2001	1980-2001	1980-1990	1990-2001	1980-2001
Meat / Meat Products	1.42	3.94	3.01	-1.36	4.96	2.76	7.40	15.51	16.78
Fish / Fish Products	-2.67	4.06	1.96	0.17	8.49	6.71	9.87	8.85	14.67
Fruits / Vegetables	3.04	7.93	4.93	2.67	5.85	4.11	12.05	18.51	13.64
Vegetable Oils	-0.68	-1.35	-0.03	-0.44	0.09	0.48	9.88	6.61	9.69
Dairy / Dairy Products	5.18	6.10	5.87	4.78	3.52	4.25	17.92	15.88	14.35
Grain Milling	2.90	1.89	2.47	2.87	3.40	2.96	10.53	9.93	10.57
Starches and Starch Products	-0.99	8.13	3.69	0.09	4.95	3.21	3.45	14.33	10.18
Animal Feeds	4.98	5.80	6.48	7.00	7.62	7.91	13.30	11.85	13.85
Bakery Products	3.83	2.76	3.11	5.32	3.56	3.91	14.40	10.17	11.71
Sugar	-5.97	-2.44	-4.30	-6.39	-2.49	-2.61	11.57	8.70	10.00
Indigenous / Refined Confectionery	5.46	5.72	5.44	8.08	4.78	7.21	18.87	15.99	18.25
Other Food Items	0.51	1.56	1.46	-2.61	2.03	1.27	12.00	5.56	8.53
Total Food Products	0.91	1.64	1.58	-2.31	1.43	0.71	11.74	9.23	10.51

Note: Annual Compound Growth Rates are calculated using exponential growth model
Source: Annual Survey of Industries (various issues), CSO, New Delhi

segments, such as meat and meat products, fruits and vegetables, grain processing, starches and starch products, animal feed, and bakery products. The growth in output for meat and meat products and fruits and vegetables has almost doubled during the last two decades. These growth trends in gross value added (GVA) for various food products suggest that there is vast scope for promoting high-value segments in the post liberalisation period.

Productivity Change in Food Processing Industry

Table 4 shows the cost composition of the food processing industry in India, which would definitely help in formulating effective strategies for the development of various food segments. The major constraint in the development of the food processing industry is timely and quality procurement of raw material, i.e., agricultural produce for processing, which accounts for about 85-90 percent of the total input cost. The absence of assured electric supply coupled with lack of other infrastructural facilities such as road, transport, storage etc., are other constraints that hinder the growth of the food processing industry. Though the cost composition in various types of food processing units varies, raw material consumption constitutes the major share.

Table 4 also clearly illustrates that economic liberalisation has increased the capital intensity in the Indian food processing industry, as the share of capital cost has

Table 4: Cost Composition of Food Processing Industry in India (%)

Group	Wages & Salaries			Cost of Capital			Material Consumed			Energy Used		
	1980-1982	1990-1992	1999-2001	1980-1982	1990-1992	1999-2001	1980-1982	1990-1992	1999-2001	1980-1982	1990-1992	1999-2001
Meat / Meat Products	9.45	7.66	4.74	6.93	8.81	8.79	78.40	78.04	81.03	5.22	5.49	5.44
Fish / Fish Products	2.95	2.41	3.37	4.29	4.24	5.22	90.43	91.06	88.15	2.33	2.29	3.25
Fruits / Vegetables	8.32	10.99	8.19	8.22	13.45	15.68	79.70	69.42	68.54	3.76	6.14	7.59
Vegetable Oils	1.76	1.53	1.79	2.38	3.17	3.61	93.17	92.16	91.02	2.69	3.14	3.58
Dairy / Dairy Products	4.88	4.93	4.90	2.97	3.43	3.99	88.22	88.32	87.60	3.93	3.31	3.50
Grain Milling	3.24	2.43	2.43	3.09	3.61	3.56	92.02	91.82	91.13	1.65	2.15	2.88
Starches / Starch Products	6.21	6.16	6.41	7.75	10.09	11.38	72.36	69.16	69.56	13.68	14.59	12.65
Animal Feeds	3.77	3.08	3.26	3.26	2.58	3.40	91.02	92.33	90.67	1.95	2.01	2.67
Bakery Products	8.93	9.00	9.25	3.73	4.82	4.65	82.76	81.15	79.71	4.58	5.03	6.39
Sugar	9.55	9.51	8.66	10.88	10.88	15.15	76.46	77.11	74.33	3.11	2.49	1.85
Indigenous / Refined Confectionery	7.99	7.93	8.98	5.15	10.32	9.65	83.20	76.82	75.61	3.66	4.94	5.76
Other Food Items	6.74	5.52	6.84	3.71	5.05	5.30	83.95	84.29	81.84	5.60	5.14	6.01
Food Industry	5.03	4.57	4.79	4.82	5.36	6.59	86.95	86.93	85.10	3.20	3.15	3.52

Source: Calculated from Annual Survey of Industries Data, CSO, New Delhi increased during the post-liberalisation period. Pattnayak and Thangavelu (2005) argue that the capital-using technical change has significant policy implications in terms of capital accumulation and increasing total factor productivity in the Indian manufacturing industry.

Table 5: Average Technical and Scale Efficiency in Indian Food Processing Industry

Group	1980-90			1990-2001			1980-2001		
	CRSTE	VRSTE	SCALE	CRSTE	VRSTE	SCALE	CRSTE	VRSTE	SCALE
Meat / Meat Products	0.417	0.918	0.460	0.764	0.882	0.852	0.606	0.911	0.665
Fish / Fish Products	0.687	0.955	0.719	0.833	0.863	0.960	0.764	0.907	0.847
Fruits / Vegetables	0.823	0.829	0.993	0.803	0.868	0.912	0.792	0.895	0.880
Vegetable Oils / Fats	0.872	0.978	0.892	0.856	0.939	0.909	0.862	0.956	0.900
Dairy / Dairy Products	0.709	0.894	0.793	0.804	0.837	0.955	0.758	0.866	0.875
Grain Milling	0.768	0.901	0.852	0.866	0.900	0.960	0.821	0.903	0.909
Starches / Starch Products	0.713	0.941	0.759	0.752	0.862	0.867	0.737	0.902	0.818
Animal Feeds	0.768	0.835	0.927	0.807	0.833	0.949	0.790	0.838	0.936
Bakery Products	0.858	0.912	0.941	0.923	0.925	0.997	0.892	0.921	0.969
Sugar Indigenous Refined	0.788	0.978	0.805	0.850	0.937	0.903	0.829	0.959	0.863
Confectionery	0.657	0.838	0.793	0.689	0.733	0.926	0.671	0.785	0.858
Others	0.851	0.999	0.851	0.953	0.968	0.984	0.900	0.982	0.917
Food Processing	0.743	0.915	0.815	0.825	0.879	0.931	0.785	0.902	0.870

Source: Calculated from Annual Survey of Industries Data, CSO, New Delhi
Note: CRSTE=Technical Efficiency from CRS DEA
VRSTE= Technical Efficiency from VRS DEA
SCALE= Scale Efficiency

The performance of the Indian food processing industry is measured in terms of technical and scale efficiency (Table 5). The technical efficiency is the product of its scale efficiency and pure technical efficiency estimated under the assumption of constant returns to scale. The values of efficiency indices equal to unity implies that the industry is on best-practice frontier, while values below unity show that the industry is below the frontier or technically inefficient. Analysis of this study shows that the average technical efficiency score is estimated to be 0.785 under the CRS model and 0.902 under the VRS model. The average scale efficiency in Indian food processing units for the entire period is estimated to be 0.870. This implies that the average technical inefficiency could be reduced by 10 percent by improving scale efficiency and eliminating pure technical inefficiencies. The efficiency scores in the food processing industry vary significantly across various types of food processing units and over time. It is also evident that the average technical efficiency scores for the food processing industry as a whole have experienced declining trends during the post-liberalisation period (1990s) over the pre-liberalisation period (1980s). The decline in technical efficiency during the post-liberalisation period may be because of high gestation lag in capital investment. However, the scale efficiency has improved from 0.815 during 1980-1990 to 0.931 during 1990-2001. This implies that market liberalisation has facilitated the enhanced investment in capital goods leading to greater capacity utilization.

Based on a literature survey, Golany and Yu (1997) argue productivity improvements in five different scenarios, which include (a) producing the same output while consuming less resources; (b) producing more output without changing the level of resource usage; (c) producing more output with fewer inputs; (d) a large increase in the output for an increase in input; and (e) a smaller reduction in the output for an increase in input consumption. Out of these five scenarios, the first three are associated with technical efficiency while the remaining are associated with scale efficiency. Input-oriented variable returns to scale (VRS) Data Envelopment Analysis Model known as BCC Model identifies the decision making units (DMUs), operating in three regions: (i) a region of increasing returns to scale (IRS), (ii) a region of declining returns to scale (DRS), or (iii) a region of constant returns to scale (CRS). Banker, Charnes, and Cooper (1984) refers to the region of constant returns to scale as the "most productive scale size" (MPSS).

The relevance of returns to scale analysis in business decision-making is a well researched area (Kang and Kwon 1993; Segoura 1998; Butler and Li 2005). The analysis provides information for decision-makers to examine their production performance and to determine the effectiveness of resource utilization. Table 6 indicates that most of the sub-sectors of the food processing industry were operating under increasing returns to scale during the pre-liberalisation period (1980-1990);

Table 6: Returns to Scale in Indian Food Processing Industry

Group	1980 - 1990	1990 - 2001	1980 - 2001
Meat / Meat products	IRS	IRS	CRS
Fish / Fish products	IRS	IRS	DRS
Fruits / Vegetables	IRS	IRS	IRS
Vegetable Oils / Fats	IRS	CRS	DRS
Dairy / Dairy Products	IRS	DRS	DRS
Grain Milling	IRS	DRS	DRS
Starches / Starch Products	IRS	IRS	CRS
Animal Feeds	IRS	CRS	CRS
Bakery Products	CRS	CRS	DRS
Sugar Indigenous / Refined	CRS	CRS	CRS
Confectionery	DRS	CRS	CRS
Others	IRS	CRS	CRS

Source: Calculated from Annual Survey of Industries Data, CSO, New Delhi
Note: CRS=Constant Returns to Scale
IRS=Increasing Returns to Scale
DRS= Decreasing Returns to Scale

except for bakery products and sugar, which had constant returns to scale, and confectionery which had decreasing returns to scale. However, the majority of the segments of the industry have moved towards constant and deceasing returns to scale during the post-liberalisation period (1990-2001), except for meat and meat products, fish and fish products, fruits and vegetables, and starches and starch products. These results clearly indicate that after market liberalisation the capital investments across the food processing industry had significantly increased, after having not been fully utilized in most of the food processing segments in the initial years.

Table 7 shows the estimated average annual rate of productivity and efficiency change in the Indian food processing industry during the last two decades. The Malmquist TFP index measures the productivity change over period t to period t+1. This output-based index explains the change in productivity level in given level of inputs. The TFP change in a firm occurs either due to technological progress (i.e., shift in the production frontier), or due to efficiency improvements in the firm (Hossain and Bhuyan 2000). A productivity value index larger than one indicates a productivity improvement and a value less than one indicates productivity decline.

Table 7: Efficiency Change, Technological Progress and TFP Change in Indian Food Processing Sector

Group	1980-1990			1990-2001			1980-2001		
	EFFCH	TECHCH	TFPCH	EFFCH	TECHCH	TFPCH	EFFCH	TECHCH	TFPCH
Meat / Meat Products	1.009	1.091	1.089	1.007	1.146	1.166	1.018	1.119	1.140
Fish / Fish Products	1.011	1.068	1.081	0.992	1.086	1.031	1.005	1.081	1.060
Fruits / Vegetables	1.038	1.058	1.100	1.130	1.072	1.151	1.068	1.071	1.112
Vegetable Oils	1.094	1.157	1.179	1.019	1.162	1.102	1.030	1.174	1.128
Dairy / Dairy Products	1.074	1.113	1.192	0.999	1.114	1.055	1.040	1.127	1.135
Grain Milling	1.020	1.014	1.011	0.998	1.038	1.018	0.999	1.033	1.012
Starches / Starch Products	0.955	1.078	1.022	1.091	1.095	1.078	1.029	1.080	1.041
Animal Feeds	1.002	1.075	1.074	1.177	1.068	1.258	1.095	1.076	1.177
Bakery Products	1.004	1.097	1.105	0.994	1.026	1.006	0.998	1.061	1.054
Sugar / Jaggery	1.001	1.055	1.054	1.002	1.030	1.027	1.002	1.057	1.055
Confectionery	1.003	1.085	1.083	1.094	1.113	1.218	1.055	1.098	1.157
Other Food Items	1.002	1.065	1.063	0.979	1.009	0.957	0.989	1.040	1.010
Food Industry	0.999	1.072	1.064	0.989	1.069	1.031	0.982	1.060	1.041

Source: Calculated from Annual Survey of Industries Data, CSO, New Delhi
Note: EFFCH=Efficiency Change
TECHCH= Technical Change
TFPCH= Total Factor Productivity Change

During the last two decades, all segments of the food processing industry experienced positive change in TFP with varied magnitude. The TFP gain is basically due to change in technological progress, and the contribution of efficiency change in TFP is small.

The overall TFP change in the Indian food processing industry declined from 1.064 during the pre-liberalisation period (1980-1990) to 1.031 during the post-liberalisation period (1990-2001). However, some of the segments have gained significantly in terms of TFP change during the post-market liberalisation period, such as animal feed (1.258), confectionery (1.218), meat and meat products (1.166), fruits and vegetables (1.151), and grain milling (1.018). A close look at the TFP results indicate that the food segments with high scope of value additions have shown positive TFP changes during the post-liberalisation period. This provides an interesting and practical relevance to policy makers and food processors for enhancing investment in these segments of the food processing sector. Similarly, a total of 6 out of 12 food processing segments have experienced declining TFP change during the post-market liberalisation period. The contribution of technological progress and efficiency change in various types of food processing shows mixed trends.

Table 8: Average Slacks in Input use in Indian Food Processing Industry

Group	1980-90			1990-2001			1980-2001		
	Energy Rs. lakh	Material Rs.lakh	Cost of Capital Rs.lakh	Energy Rs.lakh	Material Rs. lakh	Cost of Capital Rs. lakh	Energy Rs. lakh	Material Rs. lakh	Cost of Capital Rs. lakh
Meat / Meat Products	702	20060	1000	182	7496	732	401	12912	850
Fish /Fish Products	111	3022	176	13	333	36	63	1681	108
Fruits / Vegetables	159	4444	287	13	637	62	86	2550	177
Vegetable Oils / Fats	1	62	0	0	25	0	1	45	0
Dairy / Dairy Products	119	3180	178	11	391	30	66	1789	106
Grain Milling	0	9	0	1	18	3	1	14	2
Starches / Starch Products	76	1786	80	10	282	0	44	1033	40
Animal Feeds	303	7535	542	29	811	26	166	4161	284
Bakery Products	4	127	4	5	156	7	5	135	6
Sugar Indigenous / Refined	5	161	6	5	157	9	5	159	8
Confectionery	159	4765	243	24	672	57	91	2635	148
Others	7	200	11	2	32	0	4	111	5
Food Processing	137	3779	210	25	918	80	78	2269	144

Source: Calculated from Annual Survey of Industries Data, CSO, New Delhi

Table 8 provides results on target inputs and the estimated slack inputs in the Indian food processing industry. Target inputs refer to what a particular DMU ought to have consumed if it was on the efficient frontier. The slack inputs are excess inputs. The slack is calculated as the difference between actual inputs consumed minus the target input a DMU ought to have consumed. An efficient DMU will have zero input-output slack. In absolute terms, major input slack per unit was recorded in case of raw material use (Rs. 2269 lakhs) followed by cost of capital (Rs. 144 lakhs) and energy (Rs. 78 lakhs) during 1980-1981 to 2001-2002. It is interesting to note that the input slacks have comparatively declined during the post-liberalisation period as compared to the pre-liberalisation period. This may be because of modernization of production technologies to enhance resource use efficiency, as capital investment shows increasing trends across the food processing segments during the recent years.

Implications of the Study

The study provides empirical evidence on efficiency and productivity changes for each segment of the food processing industry over a period of two decades, which clearly maps the performance of food processing units at disaggregated level. It also identifies the causes of inefficiency and low productivity by analysing the input slacks. The results of the study have great managerial relevance in a number of ways. It provides a direction to new entrants into the food processing sector about the potential avenues of investment. Food segments with higher efficiency and productivity seem to be more attractive sub-sectors. Findings clearly indicate that higher efficiency and productivity changes have been experienced within the high value sub-sectors of food processing industry, which also follow the changing demand pattern towards high-value products, such as fruits, vegetables, milk, meat and confectionery. Firm managers can also consider efficiency and productivity scores as their performance indicators and, can accordingly take corrective measures after identifying the sources of inefficiency. Based on the slacks, the managers can adjust the combination of factor inputs or modernize the production process to improve the efficiency and productivity levels of their firms.

The study also suggests policy directions for the Indian food processing industry. As value addition through food processing is meagre, there is a need to have a focused approach in promoting this sector. Therefore, this sector requires policy inputs at the disaggregated level so that appropriate measures can be taken for each segment as per the requirement. High-value segments may require different levels of government interventions as compared to other segments. For example, high-value products may require more technological advancements at processing and sourcing levels to meet the customer need in an efficient manner. Similarly, the government may plan a relief package for inefficient units to enhance their performance. Findings of the study clearly indicate that maximum inefficiency comes from inefficient use of raw material, which is the major cost component of the food processing units. Government intervention in raw material sourcing for food processing units is quite critical, and necessitates policy reforms to allow direct private participation of food processors in procuring their raw material from the farmers.

Conclusions

Food processing in India has immense potential in terms of income and employment generation through value addition due to the availability of resources, labour, technology, the huge market and a favourable business environment. The level of food processing in the country is at the infancy stage and only a meagre quantity of agricultural produce is processed. The growth in the Indian food processing industry is mainly constrained due to lack of productivity augmenting technologies and limited resource utilization. Therefore, technology is the key to enhancing growth and efficiency in the food processing sector.

The analysis suggests that the food processing industry in the country is growing at a rate of about 10 percent per annum. The growth in output is largely driven by the incremental use of input doses. The average technical efficiency score is estimated to be 0.902 under the VRS model, with an average scale efficiency score of 0.870. This implies that the average technical inefficiency could be reduced by 10 percent by improving scale efficiency and eliminating pure technical inefficiencies. The technical efficiency scores for the food processing industry have declined during the post-liberalisation period (1990s) as compared to the pre-liberalisation period (1980s). The analysis of returns to scale in the food processing sector suggests that most of the sub-sectors have moved from increasing returns to scale towards constant and decreasing returns to scale during the last two decades, except for meat and meat products, fish and fish products, fruits and vegetables, and starches and starch products. This result clearly indicates that additional investment in the food processing segments with increasing and constant returns to scale will give encouraging and profitable output, whereas food segments with decreasing returns to scale need significant reorientation and modernization of the production process.

The food industry has experienced positive change in TFP with varied magnitude across sub-sectors during the pre and post liberalisation periods. The positive gain in TFP is basically due to change in technological process, i.e., shift in production frontier due to increased doses of capital input. The contribution of efficiency to TFP change is very small and needs attention for sustainable growth of the food processing sector. The variability in efficiency and TFP results across food processing sectors clearly indicate that high-value addition segments such as confectionery, meat and meat products and fruits and vegetables have shown a positive growth during the post liberalisation period. This implies that there have been structural changes in the food processing sector towards high-value segments following the changes in consumption patterns in the domestic markets. These findings also suggest that food processing segments with high-value addition opportunities have greater for investment attraction.
The reasons for inefficiency and low TFP change have been empirically analyzed in terms of input slacks. The analysis of input slacks in the food processing industry suggests that the industry is labour intensive and that the effects of the expansion

of the food industry on labour employment and productivity appear to be favourable. Analysis further shows that the food processing industry has been scale inefficient, mainly due to slacks in raw material, capital and energy use, implying that these inputs were excessively used. Policy makers and food processors may use these findings to improve productivity and efficiency in the Indian food processing industry and may work out the optimal levels of input mix by rationalizing the process of acquisition and usage of these inputs. Results indicate that the industry needs to modernize its production system to improve the capacity utilization of factor inputs, mainly of raw material, capital and energy. As raw material constitutes about 85 percent of production cost, proper methods of sourcing quality raw material for food production should be adopted by shortening the procurement process of the food processing industry. This initially requires reforms in domestic food and agricultural markets for strengthening backward linkages of food processors with the farmers through the provision of direct procurement.

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