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PRODUCTIVITY & EFFICIENCY IN APPAREL MANUFACTURING: A FIRM-LEVEL ANALYSIS FOR INDIA

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Abstract

The long-term growth and sustainability of a manufacturing industry depends on its production performance, both in terms of efficiency & productivity. Apparel manufacturing is a key industry in developing economies due to its significant contribution to employment, output, and exports. This study examines the productivity and efficiency performance of apparel manufacturing at the firm-level in India using secondary data for corporate firms. Data Envelopment Analysis (DEA), Malmquist Productivity Index (MPI) and Tobit regression are used to empirically analyse the data. The total factor productivity (TFP) has marginally improved over the study period and firms should focus on technology and pure efficiency for improvement. Firm characteristics such as scale, exporting, age and listing status have varied impact on productivity and efficiency and firms would benefit from adopting unique and customised strategies for performance improvement. The policy efforts should promote scale expansion and export promotion to ensure competitiveness in the sector.

Keywords: Apparel manufacturing, India, Data Envelopment Analysis, Technical Efficiency, productivity.

1. Introduction

Manufacturing industries need to enhance production efficiency performance to ensure growth and sustainability in the long run in competitive economic environments (Mahadevan, 2002). Apparel manufacturing sector is a key industry for developing nations with high level of competition. Apparel exports account for a huge chunk of the total exports for the South Asian countries who have 'taken many steps in recent years to support the textile and apparel sector' but need to direct attention toward addressing inefficiencies along the value chain that undercut their competitiveness (World Bank, 2016). Firms which have higher productivity and efficiency, can save time, and use inputs optimally to offer lower, competitive prices. In the Indian economy,

apparel manufacturing is a significant industry, in terms of its contribution to employment of low-skilled labour, exports and GDP. 'The share of textile and clothing in India's total exports stands at a significant 12 % (2018-19)', while readymade garments or apparel contributes around 40% of India's total textile and apparel exports (Ministry of Textiles, 2020). "Apparel is one of the largest sources of foreign exchange flow into the country" (Credit Analysis & Research Limited (CARE) Ratings, 2016). In addition, it is labour-intensive and provides employment to 'over 45 million people' and has a huge participation of 'women and rural population' (Ministry of Textiles, 2020).

India needs to focus on improving firm-level performance to gain a competitive edge in terms of technology, value added products, scale economies etc. and many of the factors that drive competitiveness are actionable at the firm-level (Bhavani & Tendulkar, 2001). Apparel manufacturing firms in India need to focus on improving efficiency and productivity gains to successfully capture emerging market opportunities (Sudha, Sekhar & Reddy, 2019). Despite government support policies at the industry level, it has been observed that productivity and efficiency performance at the firm-level remains sub-optimal (Joshi and Singh, 2012). The government and managements should consider the firm-specific characteristics for formulating & implementing policies for improving performance (Ngo, Tran, Nguyen & Nguyen, 2020). This necessitates a study of productivity and efficiency performance and related drivers at the firm-level for the industry, especially for corporate firms which are in a better position to tap market opportunities as compared to other firms.

This paper analyses the productivity growth and technical efficiency of apparel manufacturing firms in the Indian corporate sector based on secondary data. It is presumed that firm-specific characteristics influence productivity and efficiency performance. The specific research objective is to examine performance and identify drivers thereof. The remainder of the paper is organized as follows: The second section contains the literature review and research objectives; the third section contains the methodology and data, followed by the results & discussion in the fourth section and the last section concludes.

2. Literature Review

There is extensive empirical literature on the study of productivity & efficiency in manufacturing using different methodologies (Chapelle & Plane, 2005; Driffield & Kambhampati, 2003; Paul & Yasar, 2009). Productivity and efficiency of apparel sector has been studied globally by researchers at the firm-level. The studies mainly consider large-scale firms with comparatively fewer studies considering small-scale firms. Hill and Kalirajan (1993) applied the stochastic frontier analysis (SFA) and discriminant analysis to measure technical efficiency and identify the influencing factors for small-scale garment firms in Indonesia and found considerable inter-firm

variations. Wadud (2004) studied efficiency of textile and clothing firms in Australia and revealed that older, larger, and legally incorporated firms were more efficient. Yasar, Garcia, Nelson, and Rejesus (2007) found that the learning by exporting effects were strong in Turkey's textile and apparel manufacturing industry. The productivity gains from exporting were more for firms with less-developed technology and dependent on the industry structure. Paul and Yasar (2009) studied textile and apparel manufacturing plants of Turkey and found that the more productive plants start outsourcing; input subcontracting improves productivity, while output subcontracting hampers it. Vixathep and Matsunaga (2012a, 2012b) applied DEA and Tobit regression to study the firm-level technical efficiency and its determinants for the garment industry in Cambodia and Vietnam using secondary data. Their studies found that technical efficiency was influenced by various factors such as firm experience, remuneration, firm origins, scale, product specialization, exports, and location. They highlighted the need for firms to upgrade skills of the middle management and attract investment. Kapelko and Lansink (2014) studied the textile & clothing industry in thirty-nine countries using data for listed companies using a bootstrap DEA model. Mok, Yeung, Han, and Li (2010) studied the effect of export orientation on the technical efficiency of large clothing firms in China and found that firms which focus on either domestic or export market were more efficient compared to those engaged in both. Wadho and Chaudhry (2018) used primary data to study firm performance in the textile and wearing apparel sector for Pakistan using a multi-stage structural model. They reported that labour productivity and productivity growth improved due to product innovation.

Some researchers have also explored the efficiency and productivity of the apparel industry in India. Bhavani and Tendulkar (2001) studied determinants of export performance in the garment industry using SFA and regression and found that large scale operation would help in reaping the economies of scale and enhance efficiency. Bheda, Narag, and Singla (2001) used primary data from apparel manufacturing companies to study productivity and related factors and reported that based on performance, the companies' characteristics differed significantly. Leveraging the correct factors can bring significant productivity gains. Bheda, Narag, and Singla (2003) found that stagnating productivity; much lower as compared to neighbouring countries. They found that firms that invested in upgrading technology and training the supervisors, operators and managers achieved higher levels of productivity. Hashim (2005) studied the competitiveness of the Indian textile and garment industry and revealed that high unit costs resulted due to high factor prices and poor productivity. The findings favoured large-scale production and better capacity utilization to build competitiveness. Joshi and Singh (2009) estimated efficiency using DEA and found most firms experienced decreasing returns to scale. They suggested moving to optimum plant size to improve efficiency. Joshi and Singh (2010) found that from 2002 to 2007, Indian garment industry

had registered average annual TFP growth rate of 1.7 per cent. The nominal productivity growth was mainly driven by technical efficiency change and not by technological change. Joshi and Singh (2012) studied the technical efficiency and its determinants at the firm level. They found that most firms had excess production capacity and suggested improvements in input usage to improve efficiency. Gambhir and Sharma (2017) studied technical and scale efficiency of micro enterprises and reported widespread inefficiency.

From the existing literature, certain drivers of productivity and efficiency in apparel manufacturing can be identified. It has been found that there is a positive relationship between technical efficiency and firm age or experience (Vixathep & Matsunaga, 2012a; Wadud, 2004); export orientation (Hill & Kalirajan, 1993; Mok et. al, 2010; Vixathep & Matsunaga, 2012b; Yasar et. al, 2007); remuneration (Joshi & Singh, 2012; Vixathep & Matsunaga, 2012a); female workforce (Hill & Kalirajan, 1993); formal registration of firms (Chapelle & Plane, 2005; Wadud, 2004); labour productivity (Joshi & Singh, 2012); single market domain (Mok et. al, 2010); and product specialization (Vixathep & Matsunaga, 2012b). It was found that capital intensity also has a positive impact (Chapelle & Plane, 2005; Hashim, 2005; Mok et. al, 2010); however, Joshi and Singh (2012) revealed that investment in plant and machinery negatively influenced efficiency. There was positive association with financial integration (Hill & Kalirajan, 1993), but debt impacted negatively (Joshi & Singh, 2012; Kapelko & Lansink, 2014). Some studies found large scale to have a positive impact (Chapelle & Plane, 2005; Hashim, 2005; Kapelko & Lansink, 2014; Mok et. al, 2010; Wadud, 2004), while others found that smaller firms had better performance (Joshi & Singh, 2012; Vixathep & Matsunaga, 2012b).

It is evident that there is a dearth of academic research on productivity and efficiency of India's apparel manufacturing sector in recent years. There is an urgent need to examine and gain insights for formulating appropriate measures to enhance performance. This paper examines the productivity & efficiency performance of apparel manufacturing sector of India at firm-level and examines possible drivers as well.

3. Methodology & Data

3.1. Data Envelopment Analysis (DEA)

The ratio of maximum obtainable and the actual production gives a measure of production efficiency. DEA is a non-parametric technique for estimation which makes use of linear programming to identify a production frontier and was introduced by Charnes, Cooper, and Rhodes (CCR) (1978), who expanded the concept of Farrell (1957) using the assumption of constant returns to scale (CRS). All decision-making units (DMUs) or firms considered lie on or below this frontier. This methodology supports benchmarking as DMUs lying below are

considered inefficient while those on the frontier are considered efficient. DEA is most suited to measure a firm's efficiency as it can consider multiple inputs and single or multiple outputs. Banker, Charnes, and Cooper (BCC) (1984) extended the model to variable returns to scale (VRS) model by adding the convexity constraint to it and this provides results under VRS as well as CRS assumption. It also allows for decomposition of technical efficiency in the form of pure efficiency and scale efficiency. The detailed mathematical notations and concept of DEA models are explained in Coelli, Rao, O'Donnell, & Battese (2005). This study applies the input-oriented BCC model to analyse the efficiency performance of the apparel sector in India at the firm-level. Input orientation is considered as there are constraints on demand which are beyond the control of a firm or industry (Satpathy, Chatterjee & Mahakud, 2017). A firm is considered technically efficient and lies on the efficiency frontier if and only if the optimal value of the efficiency score is equal to one. A value less than one indicates a relatively inefficient firm lying below the frontier. The minimum number of DMUs required for discrimination between efficient and inefficient performers, in a single output and four input model, can be taken as four, eight, 10 or 15 (Sarkis, 2007). The DEA approach has some distinct advantages over the other approaches to efficiency measurement such as growth accounting and SFA (Grifell-Tatje & Lovell, 1995; Joshi & Singh, 2010). It does not need specification of any functional for, does not need price data or specific objective functions, refers to the best practice technology and facilitates decomposition of the index into distinct components. 'DEA excels as a tool when technology is heterogeneous and returns to scale are not constant' in an industry, for example where firms are in different life-cycle phases (Van Biesebroeck, 2007). However, it 'does not account for noise and cannot be used to conduct conventional tests of hypotheses' (Coelli et. al, 2005). DEA and its applications have been widely used to study performance at the firm level in manufacturing sector (Joshi & Singh, 2010; Mahajan, Nauriyal & Singh, 2018).

3.2. Tobit Regression & Disaggregate Comparison

Regression uses observed metric values of independent variable(s) to estimate or predict corresponding metric values of the dependent variable (Cooper, Schindler, & Sharma, 2012). Under two-stage DEA analysis, the DEA efficiency scores, lying between 0 and 1, are a constrained variable, and regressed to identify the determinants of efficiency. This makes Tobit regression, a censored regression model suitable to identify determinants of efficiency. The model is defined as:

$$y = \begin{cases} y^*; & 0 <= y^* <= 1 \\ y = 0; & y^* < 0; \\ 1; & 1 < y^* \end{cases}$$

$$y^* = \hat{a}xi + \mathring{a}t$$

$$\mathring{a}t \sim i\ e\ N\ (0, \acute{o}2)$$

where y is the DEA VRS TE score, y* is a latent (unobservable) variable. β is the vector of unknown parameters which determines the relationship between the independent variables and the latent variable. xi is the vector of explanatory variables.

Tobit regression is popularly used in two-stage DEA analysis for identification of drivers of pure technical efficiency at the firm-level (Joshi & Singh, 2012; Mok et. al, 2010; Vixathep & Matsunaga, 2012a, 2012b). Recently, there has been some debate on the suitability of Tobit vis-à-vis Ordinary Least Squares (OLS) regression model for two-stage DEA analysis (McDonald, 2009). However, given the applicability and acceptance of Tobit model, it has been applied in the paper. A disaggregate comparison by segregating the sample into sub-categories and studying the group-wise average performance and distribution has also been attempted (Kundi & Sharma, 2015).

3.3. Malmquist Productivity Index

In modern manufacturing, total factor productivity (TFP) is deemed an appropriate measure for productivity performance and is defined as an index of output divided by an index of input. Over time, an improvement in TFP indicates growth that is beyond only an increase in inputs (Mahadevan, 2002; Sharma & Mishra, 2011).

Caves, Laurits, Christensen, and Diewert (1982) developed the Malmquist Productivity Index (MPI), an application of DEA. Based on Malmquist distance functions, taking technology of a period as the reference or benchmark for a set of DMUs, it measures an index of TFP. The use of distance functions makes it possible to consider a multiple output - multiple input production model. Such functions may be of two types depending on the orientation i.e. input distance functions and output distance functions. Input distance functions look for a minimal proportional contraction of an input vector, given the output level, while output distance functions consider the maximum proportional expansion of output with the given set of inputs.

Fare, Grosskopf, Norris, and Zhang (1994) were the first to empirically apply DEA for calculating MPI and stated that the total factor productivity may have two different sources or components i.e. efficient utilization of resources and technical change. They expressed the MPI as the geometric mean of two-consecutive period indices to remove any ambiguity in choice of benchmark technology. Thus, as per MPI, TFP change (TFPCH) under constant returns to scale (CRS) is a product of technology change (TECHCH) and efficiency change (EFFCH). Under variable returns to scale (VRS), efficiency change can further be expressed as a product of technical or pure efficiency change (PECH) and scale efficiency change (SECH).

MPI helps implementation of initiatives based on component sources that need to be improved (Mahadevan, 2002). An index value of one signifies stagnation, less than one signifies regress while more than one implies progress Coelli (1996). Since the immediately previous year is taken as base, the percentage change per annum can be derived which facilitates comparison.

Popular alternatives for productivity measurement include stochastic production function models, growth accounting, co-integration models, Tornqvist index, Olley & Pakes and Levinsohn–Petrin semi-parametric methods (Goldar, 2019; Paul & Yasar, 2009; Satpathy, Chatterjee & Mahakud, 2017; Sharma and Mishra, 2011; Yasar et. al, 2007). In addition, bootstrapping has gained popularity in recent years for statistical inferences made using MPI (Kapelko & Lansink, 2014). However, the input oriented MPI has been applied in the study due to its widespread applicability and acceptance (Joshi & Singh, 2010).

3.4. Data & Variables

Corporate firms or companies have stricter rules and greater data disclosure as compared to other type of firms. The sample for this study has been restricted to the corporate firms which comprise of both large and micro, small & medium enterprises (MSMEs). The data has been extracted and compiled from two financial databases – Ace Equity by Accord Fintech Pvt. Ltd. and Prowess by Centre for Monitoring of Indian Economy (CMIE).

Prowess has been used extensively for firm-level studies in India (Mahajan, Nauriyal & Singh, 2018; Mallick & Yang, 2013; Satpathy, Chatterjee & Mahakud, 2017). Ace Equity is similar but has a better user interface and coverage of private, non-listed companies (Gambhir & Sharma, 2015b). The same variables based on published financial accounts have been extracted from both databases for the respective companies covered by them. The data was checked manually for inconsistencies, incomplete entries, and duplications. The missing figures and characteristic details were extracted and verified manually from the annual reports wherever needed. The companies were filtered based on the NIC-2008 code 14 i.e. 'Manufacture of Wearing Apparel' as the principal activity of the company. In some cases, the company was carrying out some other activity as its principal business. Such companies were excluded, and the sample was finalized based on data availability and judgement.

3.4.1. For Efficiency Analysis

The technical efficiency using DEA was measured by a single output – multiple inputs model for the year 2014-15, for a sample of 64 companies (Table 1). The financial figures were considered for efficiency measurement does not necessitate deflation of monetary values. The sample was arrived at based on data availability on all required variables and considered suitable for analysis as it accounted for almost half the market share for apparel in the corporate sector.

3.4.2. For Productivity Estimation

For MPI, the same model was adopted, however, the financial figures were deflated using relevant price indices (Table 1). This approach of deflating financial proxies for variables has been adopted in earlier firm-level studies (Joshi & Singh, 2010; Sharma & Mishra, 2011). DEA-MPI requires balanced panel data and the final sample consisted of 29 companies, accounting for one-fifth to one-fourth market share for the six years from 2009-10 to 2014-15.

Table 1 Output-Input Model for DEA & MPI

VARIABLE	MEASURED BY	DEFLATED USING
Output	Gross Sales	Wholesale Price Index (WPI) for Other Misc. Textiles
Input - Capital	Net Plant & Machinery	WPI for Textile Machinery
Input - Labour	Salaries & Wages	Consumer Price Index for Industrial Workers (CPI-IW)
Input - Energy	Power & Fuel Expenses	WPI for Fuel & Power
Input - Material	Raw Material Consumed	WPI for Textiles

Note: WPI is obtained from the Office of the Economic Adviser to the GOI, the Ministry of Commerce & Industry of India. All-India average CPI-IW has been computed using the monthly index values published by the Labour Bureau, Ministry of Labour & Employment, GOI. All the price indices were converted to the base year 2011-12.

Source: Authors

3.4.3. For Identifying Drivers of Pure Technical Efficiency

The variables for the Tobit regression and hypothesised relation between the independent and dependent variables are given in Table 2.

Table 2 Variables used in Tobit Regression

Variable Type	Variable Name	Description	Nature	Hypothesized Relationship
Dependent	VRSTE	y*: Pure Technical Efficiency	Metric	
Independent	Age	A: Number of Years from Incorporation to 2014-15	Metric	+
Independent	Export Intensity	EI: Ratio of Exports to Gross Sales	Metric	+
Independent	Capital Intensity	CI: Ratio of Capital to Labour	Metric	+/-
Independent	Liquidity	L: Quick Ratio	Metric	+/-
Independent	Size of Firm	S: Measured by Gross Plant & Machinery	Metric	+/-

Source: Author's Compilation

The equation of the Tobit regression analysis conducted for this study is expressed as:

$$⟦y^*⟧_m= α+β_1 A_m+β_2 ⟦EI⟧_m+β_3 ⟦CI⟧_m+β_4 L_m+β_5 S_m+⟦ε_t⟧_m$$

where: m represents the firm; β_1, β_2, β_3, β_4, β_5 represent parameters/coefficients to be estimated; and ε_t is the error term.

3.4.4. For Disaggregate Comparison

The productivity and efficiency results have been compared based on four disaggregate attributes (Table 3).

Table 3 Disaggregate Attributes for Comparison

Attribute	Categories	Description
Scale of Operation	MSME Large	Categories are as defined by MSME Development Act 2006 (prior to July 2020)
Export Participation	Exporting Non exporting	Based on whether the company engages in exports
Listing Status	Listed Unlisted	Whether the company's shares are listed on a stock exchange
Age	Young Middle aged Old	Based on the number of years from incorporation to 2014-15

Source: Author's Compilation

The MSME Development Act 2006, prior to July 2020, classified Manufacturing MSMEs as firms having investment in gross plant and machinery up to INR 100 million. The age groups have been created by dividing the data based on quartiles.

4. Results & Discussion

4.1. Efficiency Performance

The descriptive statistics for the input-output variables are presented in the Appendix (Table A1). The results of the efficiency analysis revealed inefficiency with average efficiency scores for CRSTE, VRSTE and Scale efficiency as 0.637, 0.746 and 0.866 respectively. The increase in the technical efficiency score from CRSTE and VRSTE indicates that there is influence of the scale efficiency component on the overall performance in the sector. Based on VRSTE scores, around one-third of the firms were operating efficiently, while only ten firms were scale efficient. This implied that firms were largely inefficient both due to an inappropriate scale of operations and the inefficient management of inputs and resources.

The inefficient enterprises were further classified into two sub-groups – Closer to Efficiency (CTE) (value greater than or equal to 0.6) and Poor Performers (PP) (value less than 0.6). In terms of pure technical efficiency and scale efficiency, around two-third and ninety percent of the inefficient firms were CTE respectively (Table 4). This implies that with appropriate and timely corrective action, the firms can move to the efficiency frontier.

Table 4 Distribution of Inefficient Firms

EFFICIENCY INDEX	Closer to Efficiency (CTE) (0.6 = Value<1)	Poor Performers (PP) (Value<0.6)	Total Inefficient
	% of Total Firms	% of Total Firms	% of Sample
CRSTE	35.9375	48.4375	84.375
VRSTE	40.625	28.125	68.75
SCALE EFFICIENCY	76.5625	7.8125	84.375

Source: Author's Compilation

In terms of returns to scale, half of the firms showed decreasing returns implying excessive plant capacities. These firms could benefit from scale economies by utilizing their facilities to the optimum level or scaling down. More than one-third of the firms showed increasing returns and would benefit by expansion of facilities. The results indicate that firms need to focus on operating at the appropriate scale to improve efficiency performance.

The analysis of residual slacks showed that none of the firms had slack on material, while more than half of the sample firms showed slack on capital. Energy and labour input had slack for more

than one-third of the firms. The results imply that while material is relatively managed more efficiently by firms, other inputs are mismanaged. There is huge scope to reduce the capital input for the existing level of output. Roy (2009) also observed that instead of using better technology to produce value added goods, firms may be simply investing in labour displacing technology and deskilling labour which is not favourable where unemployment is a major concern. As a labour-intensive industry, active measures to promote labour efficiency and productivity to improve efficient utilization of all resources should be undertaken. The firms should make investments to enrich skills through training apart from providing fair compensation to labour (Gambhir, 2020). Ray, Mukherjee, and Mehra (2016) noted that little or no upgrading takes place within the firms; few firms engage in process and functional upgrading. But product upgrading is taken up the least. The firms need to focus more on the optimum resource utilization for the machinery employed, fuel consumed, and labour engaged.

4.2. Drivers of Technical Efficiency

The results of the Tobit regression model are presented in Table 5. Contrary to expectations, none of the other variables for age, capital intensity, liquidity and size were significant. Only the coefficient for 'Export Intensity' was significant at 1%; however, the negative sign to the coefficient was contrary to expectation.

Table 5 Results of Tobit Regression

Dependent Variable	VRSTE
Independent Variable	
Age	5.11E-05
Export Intensity	0.40355***
Capital Intensity	0.005384
Liquidity	0.014366
Size	1.09E-07
_cons	0.902299***

This implied that as export intensity increased in a firm, the pure technical efficiency came down. This seems to support the self-selection hypothesis i.e. efficient firms enter the export market; but does not support the concept of learning-by-exporting. Roy (2009) observed that export firms in India increase scale without engaging in overall consolidation. They do not consider potential in the domestic market potential due to concerns such as unstandardized and small lots, marketing, and distribution hassles.

4.3. Productivity Estimates

The descriptive statistics for the output and input variables for the study period i.e. years 2009-10 to 2014-15 reveal a significant variation in the variables (Table A2 in Appendix). There was no distinct trend in TFP change (TFPCH) for the sample firms in the Indian apparel manufacturing sector (Figure 1).

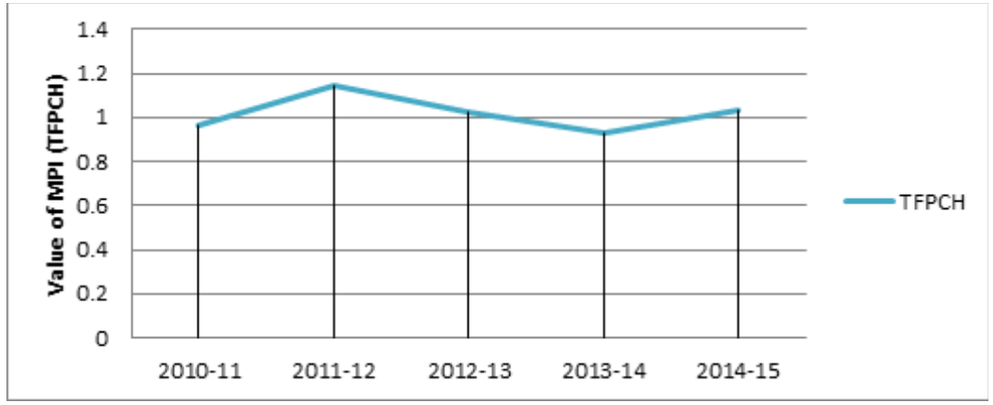


Figure 1 : Trend in MPI for Sample firms in Indian Apparel Manufacturing Industry
Source: Authors

On average it was observed that TFPCH showed slight progress, with progress on efficiency change (EFFCH) i.e. pure efficiency change (PECH) and scale efficiency change (SECH) (Figure 2). The technological change (TECHCH) showed regress in the two latest years of the study period. Highest TFPCH was observed in 2011-12 on account of progress on TECHCH and SECH. However, the PECH revealed some regress in this year. The maximum fluctuation was seen in TECHCH while SECH remained constant in recent years.

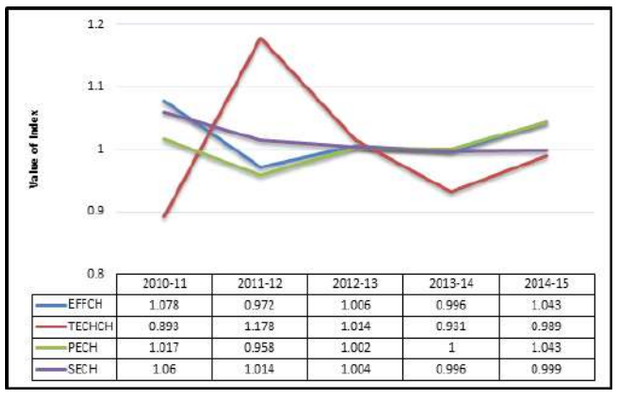


Figure 2 : Trends in Component Indices of MPI

The Indian apparel manufacturing firms in the corporate sector had a nominal growth rate of only 1.5 per cent per annum (Table 6). This was comparable to the results obtained by Joshi and Singh (2009) for the garment sector for the years 2002-2007. TECHCH showed a negative rate while rate of PECH was also extremely low. The positive average annual percentage change in TFP was a result of positive EFFCH with a larger contribution of SECH. The firms need to focus on improving technology and pure efficiency on an urgent basis.

Table 6 : Estimated Annual Percentage change in TFP and its Components

Year	EFFCH	TECHCH	PECH	SECH	TFPCH
2010-11	7.8	-10.7	1.7	6	-3.8
2011-12	-2.8	17.8	-4.2	1.4	14.4
2012-13	0.6	1.4	0.2	0.4	2.1
2013-14	-0.4	-6.9	0	-0.4	-7.3
2014-15	4.3	-1.1	4.3	-0.1	3.1
Average	1.8	-0.3	0.4	1.4	1.5

Source: Authors

The firm distribution made it evident that majority showed progress on TFPCH, TECHCH and SECH, while on PECH they experienced stagnation. Interestingly, almost equal number of firms showed regress in terms of TECHCH. Most firms experienced growth in SECH implying that the firms are making efforts to adjust the scale of operation to the most productive scale.

4.4. Disaggregate Comparison

The samples were almost equally distributed between MSME and Large firms; and skewed towards exporting, listed and middle-aged firms. The disaggregate comparison for productivity growth is given in Table 7. Most firms under all sub-categories showed progress in terms of average TFP index value. There were differences in the distribution on the component indices.

Table 7 Average Estimates for TFP and Components: Disaggregate Analysis

FIRM CHARACTERISTIC	CATEGORY	NO. OF FIRMS	EFFCH	TECHCH	PECH	SECH	TFPCH
SCALE	MSME	15	1.015	0.974	1.011	1.004	0.989
	Large	14	1.021	1.021	0.996	1.025	1.043
EXPORT PARTICIPATION	Exporting	22	1.019	1.003	1.009	1.010	1.022
	Non-Exporting	7	1.016	0.975	0.988	1.029	0.991
LISTING STATUS	Listed	18	1.008	0.991	1.005	1.003	0.999
	Unlisted	11	1.035	1.005	1.002	1.033	1.041
AGE GROUP	Young	7	0.997	0.995	1.011	0.986	0.993
	Middle Aged	16	1.029	1.000	1.003	1.026	1.029
	Old	6	1.015	0.987	0.997	1.017	1.002

Source: Authors

For technical efficiency, most firms under each sub-category showed inefficiency, with different magnitude, for both pure technical and scale components (Table 8). There were also differences in distribution for the returns to scale between sub-categories.

Table 8 : Technical Efficiency & Component Indices: Disaggregate Analysis

ATTRIBUTE	CATEGORIES	NUMBER OF FIRMS	MEAN VRSTE	MEAN SCALE EFFICIENCY
SCALE	MSME	31	0.779	0.868
	Large	33	0.716	0.865
EXPORT PARTICIPATION	Exporting	48	0.710	0.881
	Non-Exporting	16	0.855	0.822
LISTING STATUS	Listed	42	0.756	0.860
	Unlisted	22	0.729	0.877
AGE GROUP	Young	15	0.765	0.883
	Middle Aged	33	0.760	0.860
	Old	16	0.702	0.862

Source: Authors

4.4.1. On Scale of Operation

On average MSME firms showed regress while large firms showed progress in the MPI. However, the regress for MSME firms resulted from poor performance in terms of TECHCH, which coincides with the disadvantages arising from small scale operations. In terms of both PECH and SECH, MSME firms showed progress on average. In the case of large firms, TECHCH and SECH contributed to the positive MPI. However, there was a regress in PECH on average. This suggests that large scale entails challenges for efficient utilization of resources and proper management of a firm.

Majority MSME firms showed progress in terms of TFP and EFFCH, while almost two-thirds of the MSME firms showed regress in TECHCH. The results indicate that for most MSME firms, immediate corrective action, and targeted policy support to ensure improvement in technology access and use would lead to improved performance. Karabag, Lau, and Suvankulov (2014) stated that availability of government incentives is a key determinant of firm-level competitiveness. The government policy support for the sector in India is extensive ranging from export promotion and technology upgradation to training and skill development. However, the productivity and efficiency improvements in the sector are not at par with the extended support. In 2016, the Indian government rolled out a package worth INR 60 billion for the apparel sector aimed at promoting employment, productivity, and exports along the entire value chain in the sector. It included different focus areas such as reforms related to labour laws, increased coverage for duty drawback, income tax relief and also some additional incentives under the Amended Technology Upgradation Fund Scheme (ATUFS), the popular credit linked subsidy for the sector (Press Information Bureau, 2016). It can be said that while there are incentives and schemes to increase investment and access to technology, the support to improve usage is deficient. The investments in capital and machinery take time to translate into visible gains in terms of productivity and profits (Mahadevan, 2002), and it is beyond the scope of this paper to study the impact of the new policy package. The list of major schemes benefiting the apparel sector and features of the special package are given in the Appendix (Table A3 and A4).

Majority large firms performed well on TECHCH and SECH, however, they showed stagnation or regress on PECH. Technology alone cannot result in enhanced productivity and must be accompanied by gains in efficiency in the long run. The average annual percentage change in MPI was positive and significantly higher for large firms. The gap between MSME and Large firms for TECHCH and SECH component was greater than that for PECH. Large firms can easily bridge the gap by making improvements in internal management and resource utilization.

The MSME firms had higher mean pure technical efficiency score while the mean scale efficiency score for both type of firms was almost similar. While two-third of the MSME firms were technically inefficient, the proportion increased to three-fourth for large firms. A further examination of inefficient firms revealed that for both categories, most firms were CTE, and large firms had very few firms as PP on scale efficiency. In terms of pure technical efficiency, a greater number of large firms were CTE while MSME firms had an equitable mix of CTE and PP firms. This implied that pure technical efficiency is an important area for efficiency improvement for firms irrespective of scale. Most Large firms showed decreasing returns to scale whereas for MSME most had increasing returns.

4.4.2. On Export Participation

Exporting firms performed better in terms of productivity with progress on MPI and all component indices on average. Non-exporting firms showed regress on average MPI on account of poor performance on TECHCH and PECH. There was a huge difference in the average annual percentage change in TFP for exporting and non-exporting firms. For exporting firms, all components showed growth, but attention should be directed to technology component along with focus on efficiency to sustain and improve growth rate. Mallick and Yang (2013) observed that firms with low productivity do not sustain and exit the export market. Sharma and Mishra (2011) had further noted that export participation in Indian firms is generally at a low level, which may not be adequate to influence their productivity performance.

Most firms in both sub-categories showed progress in terms of TFP. However, there was a difference in the pattern for the component indices. For exporting firms, 73 percent showed progress on SECH, half showed progress on TECHCH and almost two-third showed stagnation or regress on PECH. Shanmugasundaram and Panchanatham (2011) suggested that workers should be counselled and motivated to improve quality and reduce wastage. Goldar (2019) found that for labour-intensive and low technology industries, use of imported materials had a positive impact on TFP. For non-exporting firms, the performance was divided - no firms regressed on SECH, but majority showed stagnation or regress in terms of PECH and TECHCH.

While exporting firms had a higher mean scale efficiency score, non-exporting firms had a higher mean pure technical efficiency score. The magnitude of difference for pure technical efficiency was greater as compared to scale efficiency. Most firms were technically inefficient irrespective of the export participation. The percentage of exporting firms that were pure technical inefficient was higher than that for non-exporting firms. Exporting firms work with tight deadlines and shipment dates with greater mismanagement of resources. Almost same percentage of firms were scale inefficient for both categories. Out of the inefficient firms, there were no PP firms for pure technical efficiency in non-exporting group, however, exporting group had a large number. A larger number

of exporting firms were CTE for scale efficiency as compared to pure technical efficiency while the distribution was almost equal for non-exporting firms. Most exporting firms showed decreasing returns to scale, while non-exporting enterprises showed no clear pattern. To remain competitive and improve market share, exporting firms need to focus on operating at the appropriate scale as well as improve utilization of resources.

4.4.3. On Listing Status

The average MPI for unlisted firms was showed higher progress as compared to listed firms. Unlisted firms showed progress on each of the component indices as well. The listed firms showed progress on both PECH and SECH but regress on TECHCH. This was unexpected as listed firms have better access to sources of finance and can raise funds to upgrade technology more easily. Firms undergo more scrutiny when listed on a stock exchange, and this may keep them from making capital decisions with long term obligations. Unlisted firms had a significantly higher average annual percentage change in MPI as compared to listed firms, contributed mainly by positive SECH. The firm distribution pattern on component indices was similar but varied in magnitude; majority of the firms showed progress on SECH for both categories. For PECH, majority firms irrespective of listing status showed either stagnation or regress. Listed firms had low average annual percentage EFFCH but the main cause of negative TFP growth was negative TECHCH. Listed firms should focus on investing in technology upgradation and modernization of facilities to enhance productivity performance. Technology upgradation for the apparel sector mainly implies investing in the latest and updated machinery for the various production processes such as design, sewing, cutting, buttoning, embroidery, embellishments, and 3D printing etc. The upgraded technology would help to avoid breakdowns/stoppages, reduce wastage, save time, ensure consistent quality, and enable firms to offer higher value-addition.

In terms of technical efficiency, listed and unlisted firms were close in terms of the mean scale efficiency scores while listed firms had a higher mean score for pure technical efficiency. Most firms in both categories, were inefficient in terms of both scale and pure technical efficiency and showed decreasing returns to scale. Further comparison revealed that more unlisted firms were CTE while there were almost equal number of firms that were PP and those CTE for pure technical efficiency.

4.4.4. On Age of Firm

The productivity performance for Middle-aged and Old firms was better compared to Young firms. Middle-aged firms performed best with progress on MPI and all component indices. For Old firms, there was progress on SECH but the TECHCH and PECH indices showed regress. For Young firms, TECHCH and SECH showed regress while PECH showed progress; indicating new entrants, with limited funds and experience, are cautious in resource utilization.

The average annual percentage change in MPI was highest for Middle-aged firms primarily due to positive SECH and PECH. Old firms had a positive change only on SECH while Young firms showed positive change only on PECH. The age of the firm seems to influence the aspects that need to be worked on more for greater productivity gains. Age-appropriate measures should be adopted by the firms instead of blindly copying measures adopted by others in the industry.

The firm distribution revealed that the majority firms in all age groups showed progress on TFPCH. Majority of the Young firms showed progress or stagnation on PECH and SECH. Majority Middle-aged firms showed progress on PECH and SECH. The Young and Middle-aged firms were divided between progress and regress on TECHCH. Majority Old firms showed progress on TECHCH and SECH. A larger proportion of Old firms showed stagnation or regress for PECH; as they struggle to change management styles and established systems which might be unsuitable in the current times.

The comparative technical efficiency performance showed Young firms had the highest mean pure technical efficiency and mean scale efficiency scores. The mean scale efficiency score for Middle-aged and Old firms was almost the same whereas Middle-aged firms had higher mean pure technical efficiency score as compared to Old firms. Majority of the firms in all age-groups were technically inefficient. Young firms and Old firms had a similar distribution on both pure technical efficiency and scale efficiency. Middle-aged firms had more scale inefficient firms than pure technically inefficient firms. A comparison of inefficient firms revealed that Young and Old firms had more of CTE firms on both pure technical efficiency and scale efficiency. Old firms had a fair number of PP firms for pure technical efficiency. Middle-aged firms had a larger number of CTE firms for scale efficiency, and a mix of CTE and PP firms for pure technical efficiency.

While most young and old firms showed decreasing returns to scale, Middle-aged firms showed increasing returns. This is consistent with the life cycle theory and shows that middle-aged firms were yet to reach their maximum output or plant capacity; as fairly established players in the industry who consolidate 'knowledge and technology' better, they can make use of emerging market opportunities (Driffield & Kambhampati, 2003).

5. Conclusion & Implications

This paper studies the firm-level productivity and efficiency and related drivers for Indian apparel manufacturing sector. The findings provide insight for the management and policy makers to take suitable measures to improve performance. First, the efficiency analysis showed technical and scale inefficiency, with a higher mean value for scale efficiency. Moreover, half of the firms showed decreasing returns to scale whereas one-third showed increasing returns and majority firms were closer to efficiency. There is immense scope for improvement in performance by moving to the

most productive scale and managing inputs properly. The residual slacks showed that management of inputs needs improvement and the high slack on labour could be resulting from stricter labour legislation applicable to corporate sector. Second, Tobit regression showed only export intensity as a determinant of pure technical efficiency. However, interestingly the influence was seen to be negative and warrants investigation into the causal relation in future studies. Third, the TFP growth has shown marginal improvement on average over the study period with no clear trend. The source of growth was improvement in both efficiency components – scale and pure efficiency. Technology component is pulling down productivity and firms need to focus on improving and updating the technology to sustain and improve productivity growth in the future. Moreover, majority firms were experiencing stagnation on pure efficiency, further stressing the focus on internal management and resource utilization. Last, while large and exporting firms have higher average productivity performance, MSME and non-exporting firms perform better in terms of pure technical efficiency. Listing status does not seem to affect the efficiency performance but unlisted firms have better average productivity growth. It seems to influence technology but not internal resource management. Middle aged firms perform best on average productivity while young firms have the highest average pure technical efficiency score. While not all exporting firms are efficient or productive, if firms improve efficiency, they are able to make more competitive offerings and capture a larger market share. The results of this paper highlight the areas for improvement and confirm that performance of firms may vary based on specific firm characteristics. Support measures should be designed based on specific firm characteristics and challenges for effective and lasting results.

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