Economic Affairs, Vol. **70**(01), pp. 15-21, March 2025
DOI: 10.46852/0424-2513.1.2025.4

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RESEARCH PAPER

The Effect of Perform, Achieve, and Trade Scheme on India's Textile Sector: A Panel Analysis

Anushka Chauhan and Mohanasundari Thangavel*

School of Humanities & Social Sciences, Indian Institute of Technology Indore, Madhya Pradesh, India

*Corresponding author: mohana@iiti.ac.in (**ORCID ID:** 0000-0002-6802-3757)

Received: 20-12-2024 **Revised:** 30-02-2025 **Accepted:** 07-03-2025

ABSTRACT

Several climate initiatives have been implemented to improve energy efficiency in industries. The Perform, Achieve, and Trade (PAT) initiative was implemented in India in 2012 to provide financial incentives to reduce energy intensity cost-effectively. This study offers a thorough analysis of the impact of the PAT scheme on the energy-intensive and potentially energy-efficient textile sector. Employing data for the period 2002-2022 and using a two-way fixed effects model utilizing Driscoll-Kray standard errors to account for heterogeneity in the data, it has been determined that energy intensity in the textile sector has decreased by 3.9% following the implementation of the PAT scheme. Due to the heavy presence of small- and medium-scale firms in the textile industry, difficulties arise in adopting energy-efficient technologies. In the findings, the energy-saving targets set in the scheme are insufficient to radically reduce carbon emissions.

HIGHLIGHTS

- The energy targets set for firms constitute only 6% of their total energy consumption.
- The implementation of the PAT scheme resulted in a modest 3.9% reduction in energy intensity.
- Lenient energy-saving targets led to inadequate enforcement of compliance.
- Ineffective monitoring and verification of firms pose challenges in assessing the scheme's impact.

Keywords: PAT scheme, Textile, Fixed Effect, Energy Efficiency, and Energy Consumption

The world is witnessing a proliferation of climate policies based on various mechanisms such as emissions trading, feed-in tariffs, environmental regulations, and renewable energy deployment. These policies aim to limit emissions rather than focus on energy efficiency. Energy efficiency, which entails optimizing energy consumption to achieve the same level of performance or output while reducing energy waste and minimizing the environmental impact (Lovins, 2004), is a crucial part of sustainable energy management. Recent years have seen a considerable increase in interest in energy efficiency due to growing uncertainties about climate change, energy security, and rising energy prices.

One of the four programs within the National Mission on Enhanced Energy Efficiency, which the Indian government unveiled in 2011, is the "Perform, Achieve, and Trade" scheme (PAT). This is one of India's first actions to commit to a more market-based approach to developing emission reduction strategies. Subsequently implemented in 2012, this strategy seeks to increase energy efficiency and lower greenhouse gas emissions in institutions and sectors that consume a lot of energy (Bureau of Energy Efficiency, 2020).

The textile sector is the oldest and most significant industrial sector, occupying a very prominent position in the Indian economy. With a share of

How to cite this article: Chauhan, A. and Thangavel, M. (2025). The Effect of Perform, Achieve, and Trade Scheme on India's Textile Sector: A Panel Analysis. *Econ. Aff.*, **70**(01): 15-21.

Source of Support: None; **Conflict of Interest:** None

6 percent in the nation's GDP and 13 percent in exports, this sector has been attributed as the *'silent cash cow'* as it provides employment opportunities to the skilled and unskilled workforce and allied sectors (Chandran, 2023). It is India's second-largest employer (Ministry of Textiles, 2021). Energy consumption is increasing with the increasing trend of modern mechanization and its usage in existing inefficient operating parameters. The power cost has also risen to 18 percent of the manufacturing cost (Khude, 2017). Still, there is a critical need to streamline the processes and techniques in production through energy-efficient technologies. This study examines how the Perform, Achieve, and Trade scheme affects the textile industry. Specifically, it investigates how the policy affects the energy intensity of the consumers who are designated under the scheme. The period taken for the analysis is 2002-2022, divided into two parts for a comparative study between non-policy and policy years. The paper is woven into five parts: The first part introduces the fundamental idea, the second presents the literature review, the third outlines the methodology, the fourth elucidates the results and analysis, and the fifth part concludes the paper with final thoughts, including recommendations.

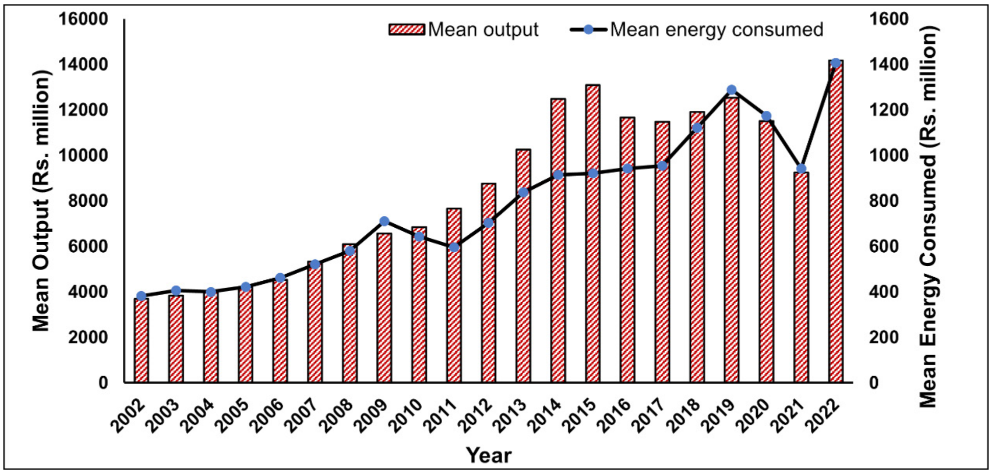
LITERATURE REVIEW

The growth in the textile industry has been upward since the 1990s due to the liberalization of the Indian economy and the introduction of sector-specific policies. In this regard, the output of the designated consumers (DCs) has increased gradually over time, as shown in Fig. 1. The mean output fluctuates throughout the years. This is because most of the raw materials in the textile sector are sourced from agriculture. For instance, cotton comprises 60% of the basket of raw material consumption in the textile sector (Ministry of Textiles, 2022a).

The deceleration observed in 2009-10 reflects the impact of the 2008 economic recession. The impact of the COVID-19 pandemic is also discernible in the graph. Energy consumption of the designated consumers has also increased steadily following the output growth. After a sharp decline around 2009, energy consumption increased sharply after 2011 as emissions in most developing nations skyrocketed after the 2008 recession recovery (Ganesan *et al.* 2015). There is very little increase in energy consumption between 2014 and 2017 due to a decline in global energy prices (World Bank, 2018). The impact of the COVID-19 pandemic slowdown is also noticeable in the graph in Fig. 1.

The PAT scheme was created under the National Mission for Enhanced Energy Efficiency (NMEEE), which is a component of the National Action Plan on Climate Change (NAPCC) introduced in 2008. The program encourages the adoption of technologies that are efficient in energy in industries with high energy consumption to reduce carbon emissions and energy use. Targets are established for sectors per the Energy Conservation Act (ECA) 2001 based on their specific energy consumption (SEC).

Energy audits evaluate baseline usage, while firms adopt energy-saving strategies, including equipment modernization and enhanced operating efficiency. Progress is assessed periodically, and industries



Source: *Authors' calculations.*

Fig. 1: Mean output and energy consumption trends in the designated consumers (DCs) in the textile sector

exceeding targets receive tradable Energy Saving Certificates (ESCerts). Companies not meeting targets may acquire ESCerts to adhere to regulatory requirements. This market-oriented mechanism guarantees adaptability while enhancing energy efficiency across sectors, aiding India's climate action objectives.

Only a few studies have been conducted to measure the impact of the PAT scheme on the energy intensity of the designated consumers (DCs), as shown in Table 1. Oak & Bansal (2019) analyzed this scheme's effect on three sectors: fertilizer, paper, cement, and pulp, and found a positive impact. Since these papers have primarily evaluated energy intensity, the results provided in Table 1 include other indicators influencing the former. In an Institute for Social and Economic Change (ISEC) paper, Misra (2019) identified a positive impact on cement while demonstrating an insignificant impact in the iron and steel sectors. The rest of the papers have focused on the energy intensity for a particular industry or the composite manufacturing sector.

Studies have demonstrated that by offering enterprises a financial incentive to invest in energy-efficient technologies and practices, the ESCerts trading mechanism has successfully driven energy efficiency gains. However, there is no effective market for trading these EScerts as there is overallocation in the case of PAT cycle I (Bhandari & Shrimali, 2018). This is because non-ambitious targets were set in this scheme for the designated consumers.

The literature suggests that the PAT scheme has effectively promoted energy efficiency improvements in energy-intensive industries. However, its implementation requires addressing several challenges and barriers, such as improving awareness and understanding of the policy among industries and providing adequate technical expertise and financial support.

Performance of the textile sector in the PAT scheme

The textile industry has exceeded its assigned targets in PAT cycles I, II, and III. As shown in Table 2, in PAT cycle I, the percentage increase of the achieved target is 95.5 percent over the assigned target. This figure is 53.4 percent and 25 percent in PAT cycles II and III. However, a percentage decrease of 85.29% and 14.28% has been recorded in PAT cycles IV and V. The Bureau of Energy Efficiency

Table 1: Review table of papers with empirical analysis of energy intensity[a]

Sl. No.	Author	Publisher	Sector	Method	Result
1.	Soni *et al.* (2017)	Resource-Efficient Technologies	Manufacturing	Multiple regression model	LI+, RI+, TII+, RMI-, OI+/-, SI+, PMI+, PI-
2	Sahu & Narayanan (2011)	Eurasian Journal of Business and Economics	Manufacturing	Standard regression model	CI+, RI+, R&DI+, TII-, PI+, size-, size^2+, age+
3	Oak & Bansal (2019)	SSRN Electronic Journal	Cement, fertilizer, pulp & paper	Difference-in difference model	PAT-, OI+, R&DI-, DID-
4.	Misra (2019)	ISEC working paper	Cement, iron & steel	Difference-in difference model	CI+, age+, PATfirm+, PATyear-
5.	Jain & Kaur (2021)	Vision	Manufacturing	Multinomial logistic model	LI-, age-, size-, CI+, PI+
6.	Kumar *et al.* (2023).	Environmental Science and Pollution Research	Manufacturing	Panel quantile regression	LI+, RI+, RMI-, PI-, PMI+, SI+, size-
7.	Goldar (2011)	Science Technology Society	Manufacturing	Multiple regression model	Size-, RMI-, TII-, R&DI-, age+

[a]*Notes*

Abbreviations: *LI – labour intensity, RI – repair intensity, CI – capital intensity, age – age of the firm, size – log of assets, PI – profit intensity, OI – outsource intensity, TII – technology import intensity, SI- software intensity, PMI – plant and machinery intensity, R&DI – research & development intensity, PATfirm – dummy variable for PAT firms, PATyear – dummy variable for PAT years*

Only significant variables are included in this table.

Source: *Authors' work.*

Table 2: Attainment of energy-saving targets in the textile industry under the PAT scheme

PAT Cycle	Year	Number of DCs	Energy Saving Target (Mtoe)	Energy Saving Achieved (Mtoe)	Percentage Increase
I	2012-15	90	0.066	0.13	95.5%
II	2016-19	99	0.088	0.135	53.4%
III	2017-20	34	0.040	0.05	25%
IV	2018-21	7	0.0204	0.003	-85.29%
V	2019-22	16	0.014	0.012	-14.28%
VI	2020-23	7	0.007	—	—

Source: *Impact of Energy Efficiency Measures Report, BEE, 2020-21.*

Table 3: Performance of the energy savings of the textile sector over energy consumption

PAT cycle	Year	Energy Consumption (Mtoe)	Energy Savings target (Mtoe)	Energy Savings over the consumption (percent)
I	2012-15	1.2	0.066	5.5
II	2016-19	1.48	0.088	6
III	2017-20	0.668	0.040	6
IV	2018-2021	0.3418	0.0204	6
V	2019-22	0.2267	0.01354	6
VI	2020-23	0.112	0.007	6.25

Source: *Pathways for Accelerated Transformation in Industry Sector, BEE, 2020.*

(BEE) enforces a PAT cycle with an implementation period of three years. However, the monitoring, reporting, and verification take at most 4-5 years as the DCs monitor their progress with the help of BEE-appointed auditors, report them to the agency, and are re-verified by the BEE (Yadav *et al.* 2021). The performance of the textile sector in PAT cycles IV, V, and VI has not been reported yet.

The textile sector has performed very well in the PAT scheme, at least till cycle III insofar. This over-achievement, however, does not necessarily indicate a considerable improvement in the sector's energy efficiency.

Also, the financing aspect of investment in energy-efficient technologies may be of concern. It is considered one of the barriers to the adequate performance of the PAT scheme (Paul, 2011). This barrier limits medium- and small-scale enterprises, mainly in the textile sector. Also, out of 14 million tonnes of production, only 2 million are covered by the PAT scheme (Bureau of Energy Efficiency, 2020). The price of the ESCert fluctuated from ₹ 200 to ₹ 1200, so there is less incentive for investment opportunities in this direction.

As pointed out in Table 3, the energy savings relative to energy consumption, quantified in million tons of oil equivalent (mtoe), have not exceeded six percent, with only PAT cycle VI covering 6.25 percent of the energy consumption. So, the targets assigned are not representative of the energy consumption of the DCs.

The market for EScerts has been established in the textile sector. During cycle I, 24 DCs bought EScerts from 32 DCs, and 18,417 energy-saving certificates were accepted, making the compliance rate 87 percent. Also, there is quite an excess of EScerts, as 56,605 more were available in the market than needed to comply, making them cheaper (Kannappan, 2021).

METHODOLOGY

Data and Variables

The variables' data have been collected using the PROWESS dataset. The data is extracted for textile firms, which are 'designated customers' in the PAT scheme, listed to comply with the energy reduction target according to a minimum specific energy consumption criterion of 3000 Mtoe. The period covers 21 years from 2002-2022, with 2002-2011 considered non-PAT years and 2012-2022 as PAT years, analyzing panel data of 75 textile companies.

This study has taken nine explanatory variables and one dependent variable in accordance with other studies, as shown in Table 4. Table 5 presents the descriptive statistics.

Econometric Analysis

This paper utilizes the two-way fixed effects model to account for the panel data's unobserved individual and time effects. The estimated multiple regression model is as follows:

$$EI_{i,t} = \alpha_i + \beta_1\, CI + \beta_2\, LI + \beta_3\, R\&DI + \beta_4\, RI + \beta_5\, TI + \beta_6\, OI + \beta_7\, PI + \beta_8\, Age + \beta_9\, size + \beta_{10}\, size^2 + \beta_{11}\, PAT\, year + e_i + v_t + \varepsilon_{i,t}$$

where all the variables have been defined in Table 5. Furthermore, the time fixed effect is indicated by v_t, the individual fixed effect is denoted by e_t, and the idiosyncratic error term is indicated by $\varepsilon_{i,t}$. This paper uses the fixed effects model based on the Hausman test's outcome, shown in Table 6. Kray-Driscoll standard errors were utilized to produce reliable estimates of the regression coefficients as the panel data had cross-sectional dependency, which was verified using the Lagrange Multiplier test of cross-sectional independence.

Table 4: Dependent and Independent variables in the study

Sl. No.	Variable	Definition	Expected Sign
1	Log of Energy Intensity (EI)	ratio of expenditure on power and fuel to total sales	–
2	Capital Intensity (CI)	ratio of the amount of capital employed to total sales	+
3	Labour Intensity (LI)	ratio of expenditure on wages & salaries to total sales	–
4	R&D Intensity (R&DI)	ratio of R&D expenditure to total sales	–
5	Repair Intensity (RI)	ratio of expenditure on repair and maintenance of the plant and machinery to total sales	+
6	Technology Import Intensity (TII)	ratio of forex spending on capital goods, raw materials, royalties, and technical know-how to total sales	–
7	Outsource Intensity (OI)	ratio of expenditure on outsourced manufacturing jobs to total sales	+
8	Profit Intensity (PI)	ratio of profit after tax to total sales	+, –
9	Age	year of study – year of incorporation	+
10	Size	log of gross fixed assets	+
11	Size^2	square of the log of gross fixed assets	–
12	PAT Year Dummy		–

Source: *Author's calculations.*

Table 5: Descriptive Statistics of the variables in the panel data

Variable	Observations	Mean	Standard Deviation	Min	Max
Energy Intensity	1288	1.42	1.497	0.85	6.65
Capital Intensity	1554	50.31	1170.37	0.00	45924.22
Labour Intensity	1554	4.68	16.60	0.00	625.71
R&D Intensity	1554	.03	.11	0.00	2.24
Repair Intensity	1554	.37	.55	0.00	7.37
Technology Import Intensity	1554	4.27	20.17	0.00	731.63
Outsource Intensity	1554	.78	1.75	0.00	17.93
Profit Intensity	1554	23.46	358.90	-1492.78	11131.24
Age	1554	41.97	23.26	15	110
Size	1329	5.16	.86	.87	7.16

Source: *Author's calculations.*

Table 6: Diagnostic Tests

	Hausman Test	Breusch-Pagan LM Test
	Coef.	**Coef.**
Chi-square test value	176.905	5402.00
P-value	0	0

Source: *Author's calculations.*

RESULTS AND DISCUSSION

The results of the two-way fixed effects regression are displayed in Table 7. The PAT year dummy is negative and statistically significant. The energy intensity of PAT firms has decreased by 3.9% on average. So, the years during the implementation of the PAT scheme have seen declining energy intensity compared to non-PAT years.

Table 7: Regression results of the panel data

(ln) **Energy Intensity**	**Coefficient**	**Standard Error**
Capital Intensity	-0.001**	0.000
Labour Intensity	0.051**	0.015
R&D Intensity	-0.204	0.193
Repair Intensity	0.201**	0.066
Technology Intensity	0.003***	0.001
Outsource Intensity	0.097***	0.023
Profit Intensity	-0.001*	0.000
Age	-0.289	0.018
Size	3.868	0.609
$Size^2$	-0.224***	0.086
PAT year	-0.039***	0.131
Constant	_cons	0
R-squared	0.711	
F-test	470.069	
AIC	2993.143	
Number of obs.	1288	
Prob > F	0.000	
BIC	3044.751	
Firm Fixed Effects	Yes	
Year Fixed Effects	Yes	

****p<.01, **p<.05, *p<.1*

Source: *Author's calculations.*

The Perform, Achieve, and Trade policy has helped enhance the energy efficiency of the textile industry firms. Other control variables, such as capital intensity, labor intensity, repair intensity, technology intensity, outsourcing, age, size, and size squared, are also significant. However, the sign of the coefficient of some variables is different than expected. For example, labor intensity is usually supposed to have a negative effect on energy intensity as labor-intensive firms consume less energy (Jain & Kaur, 2021), but the fixed-effects regression in this paper shows a positive sign. Soni *et al.* (2015) have found a positive relationship in the textile industry. This indicates lower labor productivity in the sector (Kumar *et al.* 2022). Here, the coefficient of technology intensity is positive. Such an effect is because absorbing imported knowledge requires further energy use (Kumar, 2003). Once these short-term lags have been rescinded, technology intensity may reduce energy intensity, as Sahu and Narayanan (2011) observed. Capital intensity also has a negative coefficient.

But this effect may differ from industry to industry. Kumar *et al.* (2022) identified a positive correlation between energy and capital intensity. A small but statistically significant negative relationship was found in a study of a cluster of brick enterprises in Malur, Karnataka, India (Subrahmanya, 2006). Given that 75 percent of enterprises are small- and medium-scale in the textile value chain, such a result may suggest the relevance of capital deepening in achieving higher energy efficiency.

The variable age is negative and significant. As firms become older, their energy intensity decreases. Given the fragmented and small-scale structure of the textile industry, such a relationship is plausible because older firms have more experience and resources to deal with energy efficiency. However, older firms are also characterized by outdated technological infrastructure, which entails more substantial use of energy. Literature indicates a favorable correlation between age and energy intensity. Due to the presence of simultaneity between the age and time dummy, such a result may be biased (Kumar, 2003).

The variable size has a positive sign and is significant. Nevertheless, when the square of the size is included, an inverted U-shaped relationship is found, which is also significant. Large-sized firms are less energy-intensive than small-sized firms due to economies of scale. A similar relationship exists in Sahu and Narayanan's study (2011).

Most firms are medium- and small-sized enterprises with different production processes and quality, making the textile sector complex. Only 2.7 million toe of energy consumption out of 24 million toe is covered by the DCs under the PAT scheme because of the threshold defined in the PAT (BEE, 2020). As energy constitutes a primary cost factor, comprising at least 15 to 20 percent, firms are motivated to employ energy-efficient technologies in the textile sector (Ganesan *et al.* 2015).

One of the studies by Reddy and Ray (2011) analyzed the reduction in energy use through decomposition analysis. They found that the pure intensity effect of textile industries is positive compared to other sectors. They have reported that energy intensity has risen by 47 PJ due to increased mechanization. Due to the PAT scheme, the textiles sector had achieved an energy reduction of 12.43 percent above the assigned target till PAT cycle II, which concluded in 2019 (BEE, 2020). Additionally, with the implementation of several policies, such as PM-Mega Integrated Textiles and Apparel Park (PM-MITRA) for infrastructural enhancement and Technology Upgradation: Amended Technology Fund Upgradation Scheme (ATUFS) for technical support, the impact of the PAT scheme will be enhanced in the textile sector (Ministry of Textiles, 2022a).

CONCLUSION AND POLICY RECOMMENDATIONS

This paper evaluates the cumulative impact of the Perform, Achieve, and Trade (PAT) scheme on energy intensity in the textile sector up to cycle VI. It incorporates various explanatory variables, finding all except R&D and profit intensity significant. While observational trends may not show an apparent decline in energy use, regression analysis reveals a 0.39% reduction in energy intensity attributable to the PAT scheme, indicating improved energy efficiency in production practices. Setting such lenient targets will not contribute to fulfilling the INDC goals committed in CoP 21 in Paris. Therefore, we recommend four-fold measures: First, policymakers must develop a realistic target. Second, good investment prospects in energy efficiency; third, monitoring and reporting must be done effectively for every DC in the PAT scheme, along with stricter rules and regulations; and fourth, markets for EScerts should be well established for compliance to be influential. Excess EScerts drive down the price and make it cheaper to avoid the completion of the energy use target.

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