IMPACT OF PERFORM-ACHIEVE-TRADE POLICY ON THE ENERGY INTENSITY OF CEMENT AND IRON AND STEEL INDUSTRIES IN INDIA

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Introduction

- Perform-Achieve-Trade (PAT)
- The policy sets individual limits for specific energy consumption (SEC)
- Phases of PAT and selection of industries
- Energy saving certificates (ESCerts)
- Trading of ESCerts

Review of literature

- PAT policy: Roy (2010) and Oak and Bansal (2017)
- Analysis of determinants of energy intensity in India: Sahu and Narayan (2010) and Goldar (2011)
- Energy use efficiency: Mukherjee (2008)
- Relationship between Indigenous R&D technology, technology imports and energy consumption intensity: Teng (2012)

Theoretical framework

- Mechanisms reduce pollution and environmental degradation:
  - Institutional: bargaining, principle of liability and social responsibility
  - Command and control: input controls, technology controls, output quotas and emissions licences.
  - Economic mechanisms: taxes, subsidies and marketable emission permits
- PAT falls under the purview of both command and control (obligation to reduce the SEC) and economic mechanisms (trading of ESCerts)
- Principle-agent theory: principle is the government or BEE and the agents are the designated consumers.

Data and methodology

- Data for the analysis was taken from PROWESS CMIE (Centre for Monitoring Indian Economy)
- 45 firms in total - 27 firms are designated consumers (DC) and 18 firms are non designated consumers (NDC)
- The 27 firms cover up to 85 percent of the total cement firms under PAT
- Under the iron and steel industry 67 firms have been selected under the PAT policy to reduce their specific energy consumption.
- 51 firms are selected: 30 DCs and 21 NDCs
- The data has been collected for the period 2007-2015, 2007 to 2011 is considered as the pre-policy period and 2012-2015 is considered as the policy period.
- Variables – energy intensity, capital intensity, age, raw material intensity, size (small, medium and large firms), PAT firm, PAT year and PAT interaction dummy (PAT firm*PAT year).
- The difference in difference method is used to understand the impact of PAT on the cement industry in India

Variables and their unit of measurement

S.No	Variable	Unit of measurement	Proxy	Deflator
1	Year of incorporation	Years	Age of the firm	-
2	Total capital	Rupees	Capital	Perpetual inventory method WPI: Machinery and machine tools
3	Expenditure on raw materials	Rupees	Raw materials	WPI – Average of non- food items and minerals
3	Expenditure on power and fuel	Rupees	Energy	WPI: Power and fuel
4	Sales	Rupees	Size of the firm: dummy variable – small, medium and large firms	WPI: Average of steel and sponge iron /cement and lime
5	Sales	Rupees	Sales and change in stock of finished goods is added to get output.	WPI: Average of steel and sponge iron / cement and lime
6	Change in stock of finished goods	Rupees		
7	PAT firm	Dummy variable, representing DCs and NDCs		
8	PAT year	Dummy variable, representing pre PAT and PAT period		

Descriptive statistics

- The energy intensity of the cement firms was found to be .26 and 0.07 for the iron and steel industry
- In terms of both raw material intensity and capital intensity the iron and steel industry is way ahead of the cement industry
- The iron and steel industry is found to be a capital intensive one when compared to the cement industry – the capital intensity of the iron and steel industry is found to be .12 and that of the cement industry is a meagre .003. Therefore, the iron and steel firm uses approximately five times the raw material that a cement firm uses and 40 times its capital.
- It is also found that the average age of the firms under the cement industry is 40 and that of the iron and steel industry is around 25. By this we understand that the cement industry is much older when compared to the iron and steel industry in India.
- The descriptive analysis concludes by stating that the cement industry is energy intensive and older than the iron and steel industry, whereas the iron and steel industry is more raw material and capital intensive in India.

Panel regression: Cement industry

- A panel regression is used for understanding the impact of PAT policy on the energy intensity of the cement industry in India
- Hypothesis:

Null hypothesis: The Perform-Achieve-Trade policy has no impact on the energy intensity of the cement industry in India

Alternative hypothesis: The Perform-Achieve-Trade policy has an impact on the energy intensity of the cement industry in India

- Following is the model that is estimated:

$$EI\ it = \alpha 0 + \beta 1\ Cap\ Int\ it + \beta 2\ Age\ it + \beta 3\ Medium\ firms\ it + \beta 4\ large\ firms\ it + \beta 5\ PAT\ year\ it + \beta 6\ PAT\ firm\ it + \beta 7\ PAT\ year * PAT firm\ it + U\ it, RE$$

- The random effect model is selected on the basis of the Hausman test

Results of the random effect model

Variable	Co-efficient	Std. Error	t value	P value
Capital intensity	1.8344	0.7424	2.47	0.013
Age	0.0011	0.0006	2.03	0.043
Medium firms	-0.0346	0.0311	-1.11	0.266
Large firms	-0.0784	0.0357	-2.19	0.028
PAT firm	0.0860	0.0333	2.58	0.010
PAT year	-0.0197	0.0092	-2.15	0.031
PAT interaction dummy	-0.0032	0.0113	-0.29	0.775
Constant	0.1788	0.0284	6.31	0.000
Within R^2 - 0.05, B/w R^2 - 0.21 Overall R^2 - 0.18		Rho - 0.72		

Panel regression: Iron and steel industry

- Null hypothesis: The Perform-Achieve-Trade policy has no impact on the energy intensity of the iron and steel industry in India
- Alternative hypothesis: The Perform-Achieve-Trade policy has an impact on the energy intensity of the iron and steel industry in India
- Model:

$$EI\ it = \alpha 0 + \beta 1\ KI\ it + \beta 2\ RI\ it + \beta 3\ Age\ it + \beta 4\ D1\ it + \beta 5\ D2\ it + \beta 6\ P.Y\ it + \beta 7\ P.F\ it + \beta 8\ P.Y * P.F\ it + U\ it, RE$$

  - *EI – energy intensity; KI – capital intensity; RI – raw material intensity; D1 – size dummy for small firms; D2 – size dummy for medium firms; P.Y – dummy variable for PAT year; P.F – dummy variable for PAT firm, P.Y*P.F – Interaction dummy (represents PAT firms in the policy period)*

Random effect model:

Variable	Co-efficient	Std. Error	t value	P value
Capital intensity	.0313	.0021	14.94	0.000
Raw material intensity	.0411	.0007	56.36	0.000
Age	.0005	.0003	1.39	0.165
Small firms	-.0338	.0143	-2.36	0.018
Medium firms	-.3130	.0145	-2.15	.031
PAT year	-.00026	.0041	-.06	.949
PAT firm	0.0050	.0121	0.41	.680
PAT interaction dummy	-.0023	.0050	-0.46	.654
Constant	.03370	.0163	2.06	.040
Within R^2 – 0.92, B/w R^2 - 0.32 Overall R^2 - 0.78		Rho - 0.71		

Model 2: Analysis with age dummies

- A dummy variable is used for this categorisation where all the firms that are young take the value 1 and the others take the value 0.
- The random effect model has been selected on the basis of the Hausman test.

The model is as follows:

➢ $EI\ it = \alpha 0 + \beta 1\ KI\ it + \beta 2\ RI\ it + \beta 3\ Y.F\ it + \beta 4\ D1\ it + \beta 5\ D2\ it + \beta 6\ P.Y\ it + \beta 7\ P.F + \beta 8\ P.Y * P.F\ it + U\ it, RE$

➢ *EI – energy intensity; KI – capital intensity; RI – raw material intensity; Y.F – dummy variable for young firms; D1 – size dummy for small firms; D2 – size dummy for medium firms; P.Y – dummy variable for PAT year; P.F – dummy variable for PAT firm, P.Y*P.F – Interaction dummy (represents PAT firms in the policy period).*

Results of model 2

Variable	Co-efficient	Std. Error	t value	P value
Capital intensity	.0313	.0021	14.94	0.000
Raw material intensity	.0411	.0007	56.36	0.000
Young firms	-.0213	.0115	-1.86	0.062
Small firms	-.0334	.0139	-2.46	0.014
Medium firms	-.3132	.0142	-2.21	.027
PAT year	.0019	.0038	0.47	.638
PAT firm	0.0023	.0112	0.19	.849
PAT interaction dummy	-.0023	.0050	-0.46	.643
Constant	.0563	.0134	4.10	0.000
Within R^2 – 0.92, B/w R^2 - 0.35 Overall R^2 - 0.80		Rho - 0.70		

t- test for the iron and steel industry

- A t test was done for the variable energy intensity in the PAT period, comparing the difference in mean of the DCs and the NDCs. The test has been done individually for the four year period of the PAT policy (2012-2015).

Year	P. value	DCs mean	NDCs mean
2012	.2525	.0529	.0455
2013	.0729	.0512	.0381
2014	.0386	.0942	.9463
2015	.0294	.0621	.0601

Explanation of t test

- The t test reveals that there exists a significant difference in the means of energy intensity between DCs and NDCs only in 2013.
- There exists no significant difference between the DCs and NDCs in the other years of the PAT policy. This justifies the findings of the panel regression where the PAT variables are found to be highly insignificant.
- Therefore based on the results of the panel regression which is supported by the findings of the t test, it is found that the PAT policy has no significant impact on the iron and steel industry.
- The null hypothesis stating that the PAT policy has no significant impact on the energy intensity of the iron and steel industry is accepted.

Reasons for PAT being ineffective in the case of iron and steel industry in India

- In the current analysis the cement industry is found to be more energy intensive whereas the iron and steel industry is found to be more raw material and capital intensive.
- In the case of sponge iron industry, about 60 percent of the production comes from the states of Chattisgarh, Orissa and West Bengal.
- The majority of plants here are smaller in capacity and are coal based. The PAT policy covers only the firms whose energy intake is above 30,000 MTOE –the larger plants.
- Further the large iron plants use gas and contribute about 30 percent in the production process (Maharashtra and Gujarat).

Energy consumption trends of cement and iron and steel industry in India

Production of Sponge Iron (million tonnes)						
Year	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Coal based	10.28	13.08	14.53	15.53	18.18	20.92
Gas based	4.54	5.26	5.84	5.52	6.15	5.19
Total	14.82	18.34	20.37	21.09	24.33	26.71

Cement industry					
Parameter/Yr	1950-60	1970's	1980's	1990's	Post 2000
Heat consumption (Kcal/kg clinker)	1300-1600	900-1000	800-900	650-750	650-750
Power consumption (KWh/T of cement)	115-130	110-125	105-115	95-105	80-100

Findings

- In the case of cement industry the study finds a positive relationship between capital intensity, age and PAT firm with energy intensity
- The positive relationship between capital and energy intensity is justified as it is know that capital (machinery) requires more of energy. Therefore any increase in capital would lead to an increase in the energy intensity.
- The large firms and PAT year are found to have a negative impact on energy intensity of the cement industries. This finding is justified as it is the large firms which have enough resources to invest in new technology which helps them in becoming energy efficient.
- In the case of medium and small firms, they lack resources for the same. The case of PAT year having a negative sign implies that PAT has a negative impact on the energy intensity of the cement industry.
- Therefore, the null hypothesis that the Perform-Achieve-Trade policy has no impact on the energy intensity of the cement industry in India is rejected.

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- The variables medium firms and the PAT interaction dummy are found to be insignificant. The PAT interaction dummy captures the behaviour of the firms under PAT during the PAT period.
- The PAT interaction has a negative sign, but is insignificant. This is because, the data available on PAT is restricted to three years (2012-2015), and this may not be able to capture the impact of PAT on the cement industry. This finding is similar to that of Oak and Bansal, where the interaction dummy is insignificant.
- The R^2 for the analysis is found to be .18, implying that 18 percent of the variations in energy intensity is caused due to the explanatory variables in model and the remaining 78 percent of the variations in the model are due to the unaccounted variables captured by the error term.

- In the case of the iron and steel industry the first model finds variables capital intensity and raw material intensity to have a positive relationship with the dependent variable – energy intensity. This implies that any increase in capital and raw material intensity leads to an increase in the energy intensity of the iron and steel industry.
- The variables medium and small firms are found to have a negative relationship with energy intensity when compared to the large firms. The PAT variables are found to highly insignificant.
- Further the rho value and R^2 prove the model to be a good fit. The second model divides the firms into young and old based on the age.
- The analysis finds that the young firms are significantly more energy efficient than the older firms. This finding is justified - in theory the older firms are found to be more energy intensive as compared to the newer ones.
- The coefficients of the other variables are found to be similar to the first model.
- The t test supports the findings of the panel regression. The results suggest that the PAT policy has no significant impact on the energy intensity of the iron and steel industry in India.

Conclusion

- The paper attempts to analyse the working of PAT for the cement and iron and steel industries in India
- In the case of cement industry the variables PAT firm and PAT year are found to be significant. The PAT year has a negative sign which suggests that PAT did have a positive impact on the energy efficiency of the firm – it helps in the reduction of energy intake
- Contrary to this in the case of the iron and steel industry the PAT variables are highly insignificant
- The findings of a t test for energy intensity comparing the DCs and NDCs suggest that there doesn’t exist a significant difference in the means of energy intensity across the PAT years (2012-2015), except for the year 2013


Thank
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