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ANALYSING FACTORS INFLUENCING ENERGY INTENSITY OF INDIAN CEMENT INDUSTRY

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Abstract:
India is a fast growing economy, with a considerable dependence on energy resources. Energy resources mainly comprise of fossil fuels that are highly emission intensive. In order to move towards sustainable development, it is important to reduce emissions. Since a sizable amount of emissions gets generated from the use of energy resources, it is essential to use energy more efficiently and reduce energy intensity. In India the industrial sector is the biggest consumer of energy and hence energy intensity of this sector has to be improved. To achieve this, Bureau of Energy Efficiency and Ministry of Power launched the Perform-Achieve-Trade scheme for 8 most energy intensive industries in India. This study was conducted to analyse the impact of the Perform-Achieve-Trade scheme on the energy intensity of the Indian Cement Industry, which was one of the eight energy intensive industries. Effect of other determinants like FDI, Domestic R&D, Imports and Exports were also estimated. The paper does a panel data study for the years 1997-2015. Results suggest that BEE'S PAT scheme has been successful for the Cement industry as the designated consumers have lower energy intensity on an average during the periods this scheme was announced and implemented.

Keywords: *Cement Industry; Energy Intensity; India; Manufacturing Sector; Panel Data; Perform-Achieve-Trade.*

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1. Introduction

India is a fast growing economy, with a considerable dependence on energy resources. Coal, oil and natural gas are some of the common sources of energy. These fuels are fossil fuel based that are mainly responsible for greenhouse gas emissions. The biggest perpetrator has been USA, followed by the major emerging economies viz. Brazil, Russia, India and China.

The share of fossil fuels in energy consumption in India is almost 65%, with the share of renewable energy being quite negligible at 2%. Within fossil fuels, the energy mix is dominated by coal, which is an emission intensive fuel. The industrial sector is the principal consumer of energy. In fact in 2011-2012, out of the total national energy consumption of 280934 petajoules, 47% of the demand came from the industrial sector (Energy Statistics, Government of India,

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2013). In order for India to attain sustainable development, it is essential to use the energy resources judiciously. This will be both costs saving as well as environment friendly.

The closest measure of how efficiently energy resources are being used is Energy Intensity. It is defined as the amount of energy consumed per unit of GDP. Fortunately, globally energy intensity declined from 10.2MJ/US$ to 7.9 MJ/US$ in the last decade 1990-2010 (IEA). Besides USA, the contributions of China and India have been significant. In the Indian case, energy intensity declined by almost 2.4% for the period 1990-2010 (Eurostat). In this, the contribution of the manufacturing sector has been quite important, where energy intensity fell by almost 1.8% in 2011-12. In fact, a few studies on determinants of energy intensity in the Indian industrial sector have also found a decline in energy intensity in Indian industries (Goldar 2010 & 2012; Sahu and Narayanan, 2011).

The Government of India has played a vital role in assisting the industrial sector achieves a decline in energy intensity. The government outlined 8 National Missions under the National Action Plan on Climate Change. One of the national missions is the National Mission on Enhanced Energy Efficiency (NMEEE). As a part of NMEEE, the Ministry of Power and Bureau of Energy Efficiency (BEE) launched "Perform-Achieve-Trade" (PAT) scheme in the year 2007.The PAT scheme identified 8 most energy intensive industries, viz., Cement, Aluminium, Iron & Steel, Fertilizer, Pulp & Paper, Textile, Chlor-alkali and Thermal Power. Within each industry, a set of most energy consuming plants were identified. These were called designated consumers. Almost 45%of the demand for commercial energy use in India comes from these designated consumers (BEE). Individual plant specific energy intensity reduction targets were set for each designated consumer, which was required to be met by the end of PAT Cycle I, i.e., 2012-13 to 2014-15.At the end of PAT Cycle I, designated consumers who meet their targets would be given tradable Energy Saving certificates or ESCerts, and the designated consumers who fail to meet their targets would have to buy ESCerts to continue production.

This paper has done a firm level, panel data analysis of the Cement industry in India. The objective of the paper was to test if the PAT scheme had been successful in reducing the energy intensity of the cement firms. Besides the PAT scheme, there are other factors also that influence energy intensity. The paper estimated a fixed effects model to evaluate the effect of these other factors, like FDI, domestic R&D, imports, export and size of the firm; on the energy intensity of the cement firms. The sample period of the study is April 1997-March 2015.

The rest of the paper is organised as follows. Section 2 reviews the existing studies on energy consumption and energy intensity. Section 3 describes the econometric model and variables used in the study. The empirical results are explained in section 4. The main findings of the paper are summarized in section 5.

2. Literature Review

In the area of research pertaining to energy intensity, there are both macro level studies that look at the effect of various factors on the energy intensity of a group of countries as well as micro level individual country case studies. The paper by Hubler and Keller (2009) uses macro level data to discuss the impact of FDI and gross fixed capital formation in new technologies relative

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to GDP on the energy intensity of developing countries. They estimate a fixed effects regression model for 60 developing countries (including India) for a period 1975-2004. But since the study comprises of such a heterogeneous set of countries, the results are quite ambiguous.

The paper by Pao et al (2011) tries to be more specific by restricting itself to BRIC nations. Their objective is to estimate the effect of energy consumption, GDP and FDI on carbon dioxide emissions in BRIC countries and test for granger causality between these variables for a sample period of 1980-2007. They apply a linear-log quadratic fixed effects model. Broadly the paper concludes that CO_2 emissions are highly responsive to energy consumption and GDP, but not to FDI. There is also bidirectional causality between FDI and CO_2 emissions, which could be evidence of pollution haven. More FDI increases the scale of economic activity in the countries, which further adds on to the emissions. But at the same time, foreign companies help to transfer green technology to the host countries, which play a positive role towards reducing emissions

The micro level studies focus on individual countries and thus are more rigorous case studies. Fisher-Vanden et al's (2004) paper is one of the early studies about the determinants of China's declining energy intensity. They take a sample of 2500 medium and large sized industries from 1997-1999 and identify energy price, ownership, R&D innovation, changing industry composition, and changing regional composition as the independent variables. Using the technique of Seemingly Unrelated Regression, the paper concludes that improvement in energy productivity makes a larger contribution to energy intensity than sectoral shifts.

The papers by Lei et al (2012) and He et al (2012) look at the role of FDI in transferring technology from the developed countries to China. Lei et al (2012) use autoregressive distributed lag model for the period 1960-2008 and find that FDI acts as the channel for international technology spillover. They also find that labour is a clean input because it is not correlated with CO_2 emission, while there is evidence of correlation between capital and emissions. Similarly He et al (2012) use a multivariate VAR model to test for granger causality between energy consumption, economic growth and FDI in Shanghai, China from 1985 to 2010. The paper finds unidirectional granger causality from real GDP to FDI. It also finds that increase in FDI leads to a fall in energy consumption mainly because it improves energy efficiency through technology effects.

Role of exports as a potential determinant is examined by Zheng et al (2011) and Sultan (2012) for China and Mauritius respectively. In the Chinese case, between 1999-2007, there was a sustained increase in exports, along with declining industrial energy intensity. Zheng et al (2011) hypothesized that energy intensity is correlated with exports and estimated a feasible generalized least square model using 20 sub-sectors of the Chinese industrial sector. But the results indicate that rising exports actually cause energy intensity to rise as well particularly because China's abundant low-cost coal and lax environmental laws have encouraged MNCs to transfer their energy intensive production here. Sultan (2012) evaluates the impact of various factors on the energy intensity of the textile and clothing sector of Mauritius using plant level data, with a special focus on export oriented firms. Results show that firms that produce more for exports have lower energy intensity because they cater to a larger market and can benefit from economies of scale. Moreover the demands of foreign clients may motivate them further to adopt

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energy efficient technique of production. This conclusion is in sharp contrast to what Zheng et al (2011) found for China.

Indian manufacturing sector has always been the highest consumer of energy. But in the recent past energy intensity in the manufacturing sector has been declining. Goldar (2010) finds that at the industry level there was a fall in energy intensity due to rising energy prices and technological improvement. At the firm level technology was found to be more important than prices. The other notable fact was heterogeneity in the energy intensity of firms across states. This could be due to differences in energy prices because the states that faced higher prices were forced to use electricity and coal judiciously. Within the energy intensive industries foreign firms were found to have better energy efficiency than domestic firms. Sahu and Narayanan (2011) focus on the determinants of industrial energy intensity in the Indian manufacturing for a sample period of 2000-2008. They have used a sample of 28120 observations. They estimate a panel data multiple regression econometric model with energy intensity as the dependent variable. The general empirical finding of this paper is that industries have become more energy efficient in the sample period.

3. Data, Variables and Econometric Methodology

The paper estimated a panel data model for 52 cement firms for a sample period of April 1997 – March 2015. Energy Intensity of the i^{th}firm was the dependent variable. It has been defined asthe energy consumed per unit of output produced by the i^{th}firm.But due to lack of data availability on total energy consumption and total production of cement firms, the paper has usedPower & Fuel expenditure (in Rs. million)andTotal Sales (in Rs. million) as proxy variables. Hence energy intensity was defined as:

$$Energy\ Intensity = \frac{Power\ \&\ Fuel\ expenditure\ (Rs.million)}{Total\ Sales\ (Rs.million)}$$

Power & Fuel expenditure includes total expenditure on all energy inputs used in the production process by cement firms. The explanatory variables in the study have been defined as follows:

(i) Perform-Achieve-Trade dummy variable (*PAT*) –Since PAT scheme is a qualitative variable, its effect has been analysed using a dummy variable. The dummy variable *PAT*takes value 1 for the firms that have been identified by BEE and for the years 2007-08 to 2014-15 and 0 otherwise. Though the implementation period of PAT scheme was from 2012-13 to 2014-15, the paper considers the effect from 2007-08 because the scheme was announced and designated consumers notified in 2007.

(ii) Foreign direct investment intensity (*FDI*) – This variable captured the amount of foreign investment in a firm because firms with higher FDI were likely to be technically superior. In the Chinese case there is evidence of FDI leading to a fall in energy consumption through the technology effect (Lei et al, 2012; He et al, 2012). Due to lack of data on firm level foreign capital inflows, the paper took percentage of foreign shares in a firm as a proxy, with FDI defined as anything above 10%.*FDI* is defined as the ratio of foreign direct investment to total sales.

(iii) Domestic Research & Development intensity (*RD*) – Indigenous clean technology can be developed through investments in R&D. This would help in reducing energy

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intensity of firms. In fact literature has examples of the positive effect of domestic R&D on the energy intensity of firms (Teng, 2012;Aixiang, 2011) Domestic R&D would also improve a firm's capacity to absorb superior foreign technology flowing through FDI. *RD*is defined as the ratio of domestic R&D (in Rs. million) to total sales (in Rs. million).

(iv) Import intensity (*Imp*) – This variable includes import of raw materials and capital goods and foreign exchange spending on royalty and technical know-how .*Imp* is defined as the ratio of total imports (in Rs. million) to total sales (in Rs. million).

(v) Export (*Exp*) –Export orientation of the firm would indirectly affect energy intensity through international competitiveness. Globally with consumers becoming more aware about the pollution problem, firms have started a number of efforts like carbon-labelling, which describes carbon dioxide emitted during manufacturing, transporting and disposing a consumer good. India has a "Green Rating Program" which rates industrial units in a sector on the basis of their environmental performance. Therefore firms need to project themselves as environmentally friendly in the international markets.*Exp* is defined as the ratio of total exports (in Rs. million) to total sales (in Rs. million).

(vi) Size intensity (*Size*)– This variable is proxied by Net Fixed Assets of a firm (in Rs. million). Larger firms are assumed to use better technology because they can make investments to modernize their units and can also collaborate with foreign firms. *Size* is defined as the ratio of net fixed assets to total sales.

Data on all the quantitative variables have been taken from the Prowess database. Prowess is a product of Centre for Monitoring Indian Economy that provides economic databases for India. It contains financial performance data of over 40,000 Indian companies. It was built from company annual reports, quarterly financial statements and stock exchange feeds. For the dummy variable *PAT*, The Ministry of Power, Government of India's Perform-Achieve-Trade document published in July 2012 was used to identify the names of designated consumers of the cement industry.

The paper estimated a fixed effects model to evaluate the effect of PAT scheme and that of other control variables on the energy intensity of cement industry:

$$EI_{i,t} = \alpha_0 + \alpha_1 PAT + \alpha_2 FDI_{i,t-1} + \alpha_3 RD_{i,t-1} + \alpha_4 Imp_{i,t} + \alpha_5 Exp_{i,t} + \alpha_6 Size_{i,t} + \varepsilon_{i,t}$$

Variables *FDI* and *RD* have been lagged by one period because any technology that is likely to spill over through FDI or any impact due to improvement in domestic R&D would be not be felt immediately.

4. Empirical Results

This section has evaluated the effect of the PAT scheme and that of other determinants on the energy intensity of cement firms.

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Table 1: Effect of various factors on $EI_{i,t}$ of cement firms

Variables	Model 1
PAT	-0.137**
	(0.0630)
$FDI_{i,t-1}$	1.275
	(5.890)
$RD_{i,t-1}$	-3.207
	(8.622)
$Imp_{i,t}$	-1.338**
	(0.534)
$Exp_{i,t}$	-0.565
	(1.350)
$Size_{i,t}$	0.000927***
	(1.02e-05)
Constant	-1.368***
	(0.0628)
R-squared	0.195
Observations	702

, and ***: Null hypothesis rejected at 10%, 5% & 1%; levels of significance respectively.*
Robust Standard Errors in parenthesis.

The coefficient of *PAT* was negative and statistically significant. Average energy intensity of designated consumers was lower than that of other firms in the years 2007-08 to 2014-15. This indicated that the Perform-Achieve-Trade scheme had been successful in reducing energy intensity of the designated consumers.

$FDI_{i,t-1}$ had a positive and statistically insignificant impact on energy intensity. Since cement industry has not been one of the top FDI attracting sectors, FDI did not play any role in improving the average energy intensity of the cement firms.

The impact of $RD_{i,t-1}$ on average energy intensity had been insignificant. In the past Indian manufacturing sector did not have stringent environmental laws. Therefore most of the investments could have been made towards improving the characteristics of the product than improving production technology. It is only now with the introduction of the PAT scheme that there is an incentive to control the energy consumption levels through investments in domestic R&D.

Imports had the desired effect on energy intensity. Results indicated that a rise in imports per unit sales caused average energy intensity to decrease. Since imports included foreign exchange spending on technical know-how, it implied that domestic firms were serious about cleaning their production technology by importing knowledge from abroad.

Exports, on the other hand had a negative but statistically insignificant impact on energy intensity. India has not been a major exporter of cement, despite the industry having a lot of excess capacity. This was mainly due to the high taxes imposed by the government, infrastructure constraints at the ports and encouragement to cement imports (which could be because of declining availability of coal for cement production). As per the India Cement

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Review, prior to 2007 exports were rising. But they declined quite steeply between FY2007-FY2012. Since our domestic per capital consumption is far less than that of other developing countries like China, India should take advantage of economies of large scale production by expanding to foreign markets. Our potential targets could be countries like Bangladesh, Nepal, Sri Lanka, Maldives and UAE mainly because they are geographically closer and transportation can be a major cost as cement is a bulky product.

Finally, a rise in $Size_{i,t}$ caused average energy intensity to rise and the results were statistically significant. Large sized firms would have more resources to make investments in improving production technology. But absence of stringent environmental laws had not encouraged firms to invest in technological up-gradation.

5. Conclusion

India has been one of the major consumers of primary energy that includes emission intensive fossil fuels. But the manufacturing sector, which is the main consumer of energy, registered a decline in energy intensity. The paper analysed if the PAT scheme had contributed towards decline in energy intensity of the cement firms. The paper found that designated consumers have lower energy intensity than the other firms in the periods PAT scheme was announced and implemented. This trend is encouraging since these firms were the most energy intensive firms within the industry. PAT scheme is also efficient since it depends on trade in ESCerts, which is a marketable instrument. A successful implementation of a market based scheme like PAT would encourage the government to extend its scope to incorporate more firms within the existing eight industries. The scheme can also be extended to include more industries beyond the current eight industries. A fall in energy intensity would also play an extremely crucial role in helping India reduce carbon emission by 20-25% by the year 2020.

References

[1] Aixiang, T., Research on Relationship between Energy Consumption Quality and Education, Science and Technology based on Grey Relation Theory, Energy Procedia.5, 2011, 1718- 1721.
[2] Fisher-Vandena, K., Jeffersonb, G., Liuc, H. and Tao, Quan, What is driving China's decline in energy intensity?, Resources and Energy Economics. 26, 2004, 77–97.
[3] Goldar, B., Energy Intensity of Indian Manufacturing Firms: Effect of Energy Prices, Technology and Firm Characteristics, Science, Technology & Society. 16(3), 2010, 351-372.
[4] Goldar, B., Input Substitution and Technical Change in Indian Manufacturing, 1973-2007, The Journal of Industrial Statistics. 1 (2), 2012, 169 – 181.
[5] Government of India, Energy Statistics 2013, Central Statistics Office, National Statistical Organisation, Ministry of Statistics and Programme Implementation. 2013.
[6] He, W., Gao, G. and Wang, Y.,The relationship of energy consumption, economic growth and foreign direct investment in Shanghai, Advances in Applied Economics and Finance (AAEF) 507. 3(1), 2012.
[7] Hübler, M. and Keller, A., Energy Savings via FDI Empirical Evidence from Developing Countries, Environment and Development Economics. 15 (1), 2010 59-80.
[8] Lei, Rihui, Zhang, Y. and Wei, S., International Technology Spillover, Energy Consumption and CO2 Emissions in China", Low Carbon Economy. 3 (3), 2012, 49-53.
[9] Oak, H., Factors Influencing Energy Intensity of Indian Cement Industry, International Journal of Environmental Science and Development.8 (5), 2017.

[10] Oak, H., Measuring Perform-Achieve-Trade: Analysis of Indian Cement and Pulp & Paper Industries"; International Journal of Environmental Science and Development.8 (12), 2017.
[11] Oak, H. and Bansal, S., Perform-Achieve-Trade Policy: A Case Study of Cement Industry for Energy Efficiency, Discussion Paper in Economics, Centre for International Trade and Development, School of International Studies, Jawaharlal Nehru University, DP 1705, 2017.
[12] Pao, H. and Tsai, Chung-Ming, Multivariate Granger causality between CO2 emissions, energy consumption, FDI and GDP: Evidence from a panel of BRIC (Brazil, Russian Federation, India, and China) countries, Energy. 36, 2011, 685-693.
[13] Perform Achieve and Trade, July 2012, Ministry of Power, Government of India.
[14] Prowess Database (CD accessed from JNU Library).
[15] Sahu, S. and Narayanan, K,Determinants of Energy Intensity in Indian Manufacturing Industries: A Firm Level Analysis, Eurasian Journal of Business and Economics. 4 (8), 2011.
[16] Sultan, Riad, An investigation of the determinants of energy intensity for the design of environmental strategies in emerging markets, Paper presented in the workshop "Perspectives of Emerging Markets" Organized by the Faculty of Law and Management and the WTO Chair at the University of Mauritius (UoM) and HTW Berlin – University of Applied Sciences as part of the DAAD Partnership on Economic Development, 2012.
[17] Teng, Indigenous R&D, Technology Imports and Energy Consumption Intensity: Evidence from Industrial Sectors in China", Energy Procedia. 16, 2012, 2019-2026.
[18] Zheng, Y., Jianhong Qi, and Xiaoliang Chen, The effect of increasing exports on industrial energy intensity in China"; Energy Policy. 39, 2011, 2688–2698.

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