IMPACT OF POLICY INTERVENTIONS ON THE PERFORMANCE OF ENERGY-INTENSIVE INDUSTRIES IN INDIA: WITH SPECIAL REFERENCE TO PERFORM, ACHIEVE AND TRADE PHASE-I

A thesis submitted to the
University of Petroleum and Energy Studies

For the award of
Doctor of Philosophy
In
Economics (Management)
(School of Business)

BY
ANUKRITI SHARMA

December 2019

SUPERVISOR (s)

Dr. Hiranmoy Roy
Dr. Narendra Nath Dalei

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Department of Economics and International Business
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June 2020

DECLARATION

I declare that the thesis entitled IMPACT OF POLICY INTERVENTIONS ON THE PERFORMANCE OF ENERGY-INTENSIVE INDUSTRIES IN INDIA: WITH SPECIAL REFERENCE TO PERFORM, ACHIEVE AND TRADE PHASE-I has been prepared by me under the guidance of Dr. Hiranmoy Roy, Associate Professor & Head and Dr. Narendra Nath Dalei, Assistant Professor (SS) in Department of Economics and International Business, School of Business, University of Petroleum and Energy Studies. No part of this thesis has formed the basis for the award of any degree or fellowship previously.

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DATE: 12-06-2020

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CERTIFICATE

This is to certify that the thesis entitled **"IMPACT OF POLICY INTERVENTIONS ON THE PERFORMANCE OF ENERGY-INTENSIVE INDUSTRIES IN INDIA: WITH SPECIAL REFERENCE TO PERFORM, ACHIEVE AND TRADE PHASE-I"** is being submitted by **Ms. ANUKRITI SHARMA** in fulfillment for the Award of DOCTOR OF PHILOSOPHY in (Economics / General Management) to the University of Petroleum and Energy Studies. Thesis has been corrected as per the evaluation reports dated 28/04/2020 and all the necessary changes / modifications have been inserted/incorporated in the thesis.

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EXECUTIVE SUMMARY

The growth process in all sectors of the economy is driven by the industries which is the most prominent sector contributing to GDP of India. Industry sector contributes around 29.73 percent of our GDP (MoSPI, 2018-19). Being high in energy consumption, of the aggregate commercial energy consumption in India, industrial sector accounts for around 50 percent consumption. Among the industrial sector, the industries like thermal power plants, iron and steel, pulp and paper, textiles, cement, fertilizers, chlor alkali etc. consumes greater than 60 percent of the aggregate energy consumed by industries in India (BEE, 2011).

The proportion of energy cost in total cost of production is 65 percent higher in developing countries including India in comparison to developed countries. The most simple and cost-effective way to tackle climate change problem, breathe clean air, improve competitive position of our businesses and reduce energy cost is Energy efficiency (Industrial Development Report, 2011).

As highlighted by our discussion energy cost forms a huge proportion of total production cost in Indian industries and therefore it is also affecting its competitiveness and profitability. The most feasible and best method to reduce energy intensity of Industries is to implement energy efficiency practices. India has also made reasonable progress in implementing energy efficiency practices in India. The most prominent out of these are Energy Conservation Act (ECA), 2001 and Perform Achieve and Trade (PAT), 2012. As per Bureau of Energy Efficiency, PAT Cycle-I (2012-15) was successful and overachieved its target but there were few anomalies in the structure of the program and the targets being easily achievable (Bhandari, Shrimali, 2017) and also no clarification on the trading of ESCerts, oversupply of ESCerts due to easily achievable targets and hence low price of ESCerts in the market as per Hindu Business Line article, May 2018 and other reports and authors.

Thus our study focuses on studying whether these policy initiatives have any impact in reducing the energy intensity of Indian industries or not and their overall performance in terms of profitability, production and emissions by estimating energy intensity, profitability, production and emissions of these industries pre and post implementation of ECA and PAT Cycle-I.

Following are the research objectives of our study:

- **(i)** To study the energy intensity of energy intensive industries during pre and post policy intervention period
- **(ii)** To study the impact of energy cost and policy intervention on profitability and productivity of selected industries
- **(iii)** To study the emission intensity of selected industries during pre and post policy intervention period

In order to achieve the above objectives, this thesis is organised into 7 chapters namely, Introduction, Literature Review, Research Methodology, Estimation of Energy intensity in Energy-intensive Industries in India, Impact of Energy cost and Policy intervention on Profitability and Production of Industries, Estimation of Emissions intensity in Energy-intensive Industries in India, Conclusion and Recommendation.

For the first objective, estimation of energy intensity using various independent variables affecting it has been done. The variables found to be significantly affecting energy are profit margin intensity, size of firm in terms of sales and assets and technology import intensity. As the value of these variables increases, energy intensity of firms will decline. PAT doesn't seem to have affected energy intensity of industries much so decline in energy intensity of industries over time could be attributed to other factors such as technology imports, increase in size of firms in terms of sales and assets etc.

For the second objective, profits were found to be significantly affecting both energy cost and production of firms. PAT was found to be adversely affecting profit margin intensity which seems to be a bit contradictory while ECA was found to be favourably affecting profit margin intensity of firms. More profits of firms implies more production levels.

For the third objective, not very good results have been found for the variable emission intensity. The variable size of the firm in terms of sales and assets and the variable labor intensity were found to be significant. For the Aluminium, Chlor-alkali and Textile sector, PAT and ECA have seem to reduce emission intensity of firms.

The main conclusions derived from our analysis are: PAT doesn't seem to have affected the energy intensity of industries much though ECA have. Also, our business problem stating energy cost in industries adversely affecting their profits have also been well supported by our results.

Another main objective is to study the impact of PAT Cycle-I (2012-15) on energy intensity of energy-intensive industries. As per Government records, BEE, PAT first cycle (2012-15) has been successful leading to significant reduction in energy consumption. The first cycle results showed that the industrial units covered under PAT have together succeeded their target by around 30 percent with total energy savings of about 8.67 mtoe. These 478 units covered under PAT accounts for around two percent of total commercial energy consumption in India. Also it has contributed to emission reduction by around 35 percent more than the targeted emission reduction.

Though it is too early to judge the success of PAT scheme as only one cycle of PAT has been completed but as highlighted by many reports and authors there are some anomalies in this scheme which needs to be overcome in order to make it successful. The main anomalies are in changes in power mix, fuel mix, market demand and unforeseen shutdown in the data were found during the monitoring and verification stage which has also led to oversupply of ESCerts (energy trading certificates connected to PAT) in market and therefore, PAT Cycle-I targets were easily achievable, targets are not strict enough to lead energy efficiency beyond business-as-usual and therefore not lead to any long-term investment. PAT market may not form, pricing of tradable white certificates, no floor price, penalty charges. If these anomalies are overcome, PAT could be a promising scheme.

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Anukriti

Date: June, 2020 (Anukriti Sharma)

Place: Dehradun

CONTENTS

AABREVIATIONS

BP SRWE: BP Statistical Review of World Energy
ET : Economics Times
Mtoe : Million Tonnes of Oil Equivalent
IEA : International Energy Agency
GHG : Greenhouse Gas
PBL : Netherlands Environmental Assessment Agency
TERI : The Energy and Resources Institute
GDP : Gross Domestic Product
MoSPI : Ministry of Statistics and Programme Implementation
BEE : Bureau of Energy Efficiency
AEEE : Alliance for Energy Efficient Economy
ASSOCHAM : Associated Chambers of Commerce and Industry of India
UNEP : United Nations Environment Programme
PwC : Price Waterhouse Coopers
UNIDO : United Nations Industrial Development Organisation
EBITDA : Earnings before interest, tax, depreciation and amortization
GW : Gigawatt
NAPCC : National Action Plan on Climate Change
NMEEE : National Mission for Enhanced Energy Efficiency
ECA : Energy Conservation Act
PAT : Perform, Achieve and Trade
ESCerts : Energy Savings Certificates
DC : Designated Consumers
TWh : Terawatt-hour
Mt CO_2 : Metric Tons of Carbon-dioxide
IPCC : Intergovernmental Panel on Climate Change
TFP : Total Factor Productivity
KLEM : Capital, Labor, Energy, Material Production Function
EKC : Environmental Kuznets Curve
RO : Research Objective
CD : Cobb-Douglas production function
CMIE : Centre for Monitoring Indian Economy
kWh : kilowatt hour
Cr : crores
DECC : Department of Energy and Climate Change
Kg CO_2e : Kg Carbon-dioxide Equivalent
IIP : Index of Industrial Production
FE : Fixed Effect Model
RE : Random Effect Model
OLS : Ordinary Least Squares
GLS : Generalised Least Squares
BLUE : Best Linear Unbiased Estimator

LLC : Levin–Lin–Chu Unit-root test
IPS : Im-Pesaran-Shin Unit-root test
LM Test : Breusch and Pagan Lagrangian multiplier test
NDCs : India’s Nationally Determined Contributions
IEX : Indian Energy Exchange

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CHAPTER 1

INTRODUCTION

1.0 Introduction

The most important constituent that is necessary for all development in the economy is Energy. In fact the relation between the two is a prominent one. For a country to develop energy is required. Energy consumption in India has been steadily increasing. According to BP Energy Outlook 2017, in India consumption of energy grows at the rate of 4.2 percent a year which is faster than all major countries in the world and will overtake China. Among Asian countries, India is the second largest energy consumer since 2008.

India holds the third position as fossil fuels consumer (primary energy) in the world (BP SRWE, 2016). The aggregate consumption of primary energy in India was around 100 mtoe (The ET, January 27, 2017). The industrial sector in India consumed about 30 percent (185 Mtoe) of the total final energy consumption of around 527 Mtoe in 2013. (India Energy Outlook, IEA, 2015). In the list of GHG emitters in the world, India holds third rank after China and U.S. in 2016, with its greenhouse gas emissions increasing at a high rate of 4.7 percent in comparison to the last year (PBL, September 29, 2017). One fourth of total GHG emissions in India is contributed by industries (Gupta et al. 2017).

As per Planning Commission of India, the energy intensity of India's Gross Domestic Product is on a decreasing trend since 1981. As per TERI, 2018, Energy intensity in India is falling even though the economy is growing and energy demand is rising indicating good energy efficiency practices. It can be seen from Table 1.1 and Figure 1.1 representing trends in India's Energy intensity that Energy intensity (Mega Joules per Rupee) has been declining over the years.

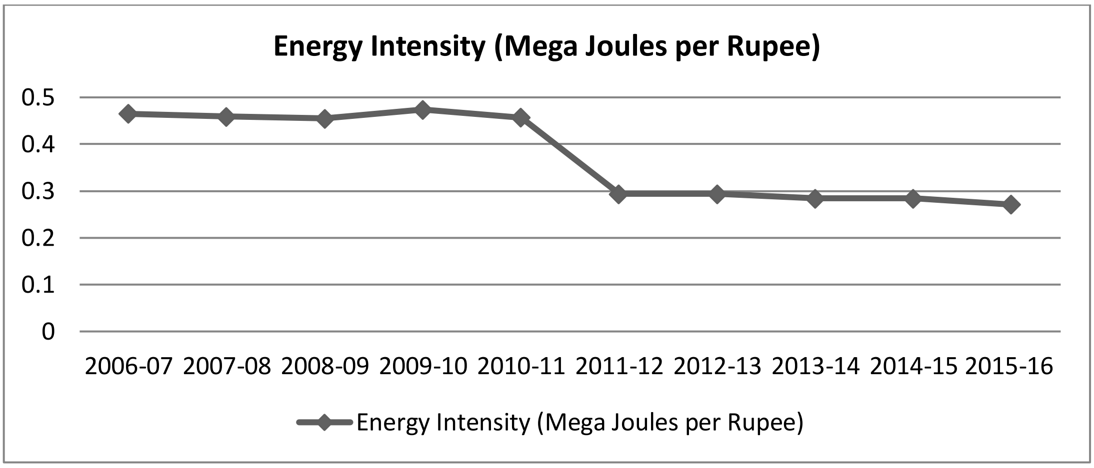
Table 1.1 : Trends in Energy intensity in India

Year	Energy Intensity (Mega Joules per Rupee)
2006-07	0.465
2007-08	0.459
2008-09	0.455
2009-10	0.474
2010-11	0.457

2011-12	0.294
2012-13	0.294
2013-14	0.284
2014-15	0.284
2015-16	0.271

Source : TERI, 2015

Figure 1.1 : Trends in Energy intensity in India



Source : TERI, 2015

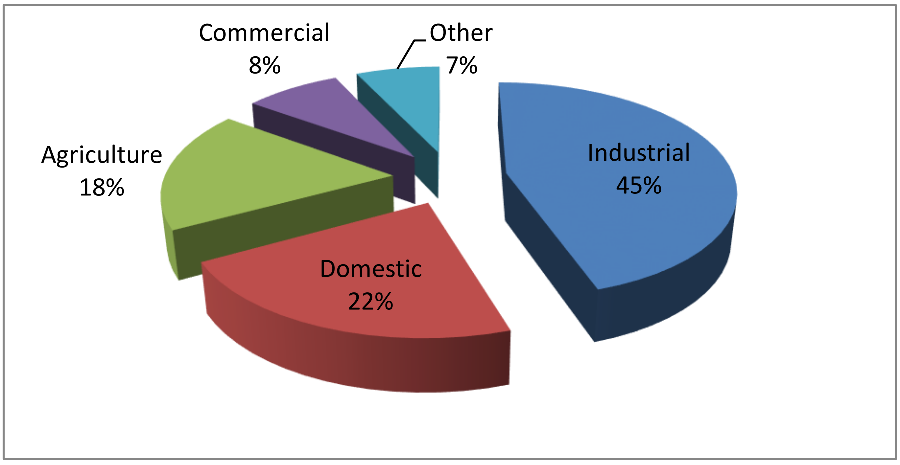
The growth process in all sectors of the economy is driven by the industries which is the most prominent sector contributing to GDP of India. Industry sector contributes around 29.73 percent of our GDP (MoSPI, 2018-19). Being high in energy consumption, of the aggregate commercial energy consumption in India, industrial sector accounts for around 50 percent consumption. Among the industrial sector, the industries like thermal power plants, iron and steel, pulp and paper, textiles, cement, fertilizers, chlor alkali etc. consumes greater than 60 percent of the aggregate energy consumed by industries in India (BEE, 2011).

As can be seen from Figure 1.2, Industry sector constitutes around 45 percent of aggregate energy consumption in India.

At industry level, Energy intensity is defined as the total energy consumption for producing a quantity/unit of output. Energy intensity is one of the most appropriate measure of Energy Efficiency, reducing energy intensity implies higher energy efficiency.

Table 1.2 and Figure 1.3 represent the trend of Energy intensity in Indian industries. It can be inferred that Energy intensity in Indian industries has been increasing over the years though as pointed before that overall energy intensity in India is on the declining trend. Thus, energy intensity of industries needs to be checked.

Figure 1.2 : Energy Consumption Pattern in India (%)



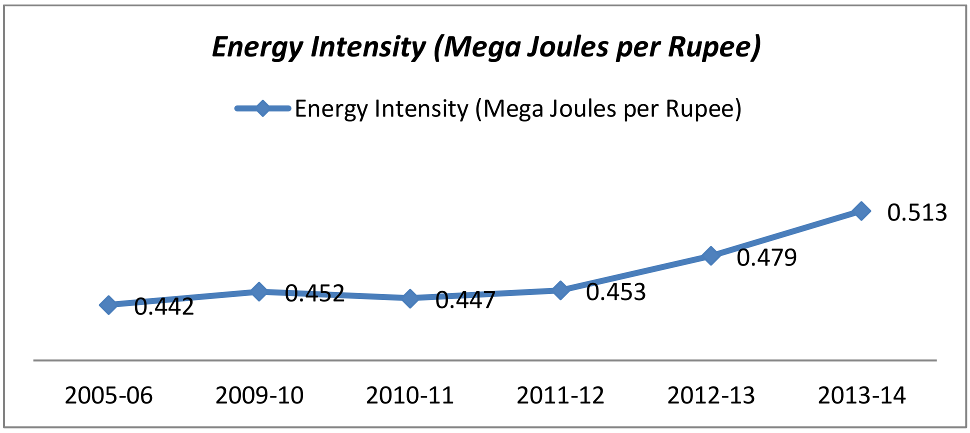
Source : Energy Policy Report, Planning Commission, India

Table 1.2 : Energy Intensity of Indian Industry

Years	Energy Intensity (Mega Joules per Rupee)
2005-06	0.442
2009-10	0.452
2010-11	0.447
2011-12	0.453
2012-13	0.479
2013-14	0.513

Source: TERI, 2015

Figure 1.3 : Trend in Energy Intensity of Indian Industry



Source : TERI, 2015

According to World Steel Association, 2016, Energy constitutes around 20 - 40 percent of total steel production cost. As can be seen from the Table 1.3, cost of energy inputs forms a huge proportion of aggregate cost of production particularly in Cement, Iron and Steel, Aluminium, Fertilizer, Chlor-Alkali sectors.

Table 1.3 : Energy Cost as a percentage of Production Cost

Sector	Energy Cost as a percentage of Production Cost
Cement	40
Aluminium	33.4
Iron & Steel	30
Pulp & Paper	25
Chlor Alkali (Caustic Soda)	60
Textiles	17
Fertilizer	60

Source : AEEE, Shakti Foundation December 2011, PAT Booklet, Ministry of Power July 2012, ASSOCHAM 2006

According to Industrial Development Report, UNIDO 2011, industry profits depends on difference between sales revenue and input costs. There are two ways to increase profits either by increasing output or price or by decreasing cost. In order to change the production level or prices it will depend on the industry structure and its market competitiveness. More competitive markets have lesser avenue for changing price. Cost of production includes cost of labor and capital and other factors of production such as materials and energy,

In short run, cost of production may be reduced by optimally utilizing production methods, making use of cheap factors of production and by improving efficiency in usage of energy and material inputs while in the long run this can be achieved by introducing new equipment.

Though more fruitful is to minimize all types of cost of production and hence total costs but since managers have time constraint, they focus on reducing that expenses which forms huge proportion of the total costs. Hence, the main focus of managers is to reduce the energy input in industrial processes which also forms huge proportion of total production costs. The various determinants of firm's energy cost are intensity of energy usage in the production processes, energy price, and energy usage efficiency of various production processes and other operations such as warehouses and buildings.

The proportion of energy cost in total cost of production is 65 percent higher in developing countries including India in comparison to developed countries. The most simple and cost-effective way to tackle climate change problem, breathe clean air, improve competitive position of our businesses and reduce energy cost is Energy efficiency (Industrial Development Report, 2011).

Many authors and reports highlighted the importance of energy efficiency as a means to reduce cost of production in Indian industries. The most important means for a nation to lower its energy and emission intensity is to indulge in energy efficiency and low carbon growth practices.

According to UNEP, 2006, Indian industries indulge in practicing energy efficiency measures in order to reduce their cost of production, cost of energy and consumption of energy in their processes, with all three objectives being of equal importance. About 20-30% of energy cost could be reduced by purchasing energy efficiency products and efficient management of facilities in iron and steel, fertilizer sector as per PwC report, 2010. As per the study by Mukherjee, 2010, that a typical manufacturing firm can produce the same quantity of output even by reducing its energy input by around 14 percent. Also, a firm with the given technology can reduce its energy consumption and still increase its output simultaneously by around 4 percent just by engaging in technical efficiency. In improving energy security, economic performance and environmental sustainability, industrial energy efficiency can play a key role (Tanaka, 2011)

According to Energy Sector Management Assistance Program; World Bank; Government of India, 2011, if we can overcome barriers to energy efficiency improvements there exists significant potential for Indian industries in terms of energy and emission savings.

Also, as highlighted and also very obvious from the facts above that as energy cost forms a huge proportion of total production cost in Indian industries, investing in energy efficiency measures and reducing energy intensity will also be helpful in increasing industry profits and thereby competitiveness.

This relation between reducing energy intensity and increasing profits is also highlighted by many reports and authors. According to World Steel Association, due to energy efficiency improvements there is decline in total production cost and hence improved competitiveness. As per UNIDO 2011, it has been emphasized in the energy economics literature that energy efficiency may provide both monetary and non-monetary benefits and it has also be confirmed by many studies that energy efficiency may increase firms' profitability.

Industrial Development Report, 2011 highlighted that the most simple and cost-effective way to tackle climate change problem, breathe clean air, improve competitive position of our businesses and reduce energy cost is Energy efficiency. As per ASSOCHAM report 2009, high energy costs is killing the competitiveness of Indian industries such as aluminium. The share of energy component has reached around 40 percent in the manufacturing sector. Thus energy cost is a significant component of India's industrial performance.

According to Australian Government, Department of Industry 2014 report, particularly in metals industry their energy cost is equal or sometimes even greater than companies' EBITDA which is a standard measure of profitability in accountancy. A 5 percent increase in these companies' EBITDA is possible by implementing energy efficiency practices. Practising energy efficiency in highly impacted companies will help reduce energy costs by about half an average.

Therefore, competitiveness of the companies' are also affected in terms of their reduced profitability with energy cost forming high proportion of their production cost.

1.1 Policy Measures implemented for improving Energy Efficiency in Indian industries

As per World Energy Investment report by the International Energy Agency, published May, 2019, India witnessed fastest energy investment growth in the world at a record 12 percent between 2015 to 2018, to around $85 billion. In comparison to any other sector in India, Industry has witnessed higher improvements in energy efficiency since the late 1980s (Ray 2007). In comparison to other regions of the world, energy consumption in Indian industries is still high but there is rational decline in energy intensity of industries in recent years. Also, India's industrial sub-sectors has huge variation in terms of a diverse range of vintages, production capacity, the quality of raw materials and product mixes.

In order to reduce energy consumption and promote energy efficiency in the country, Ministry of Power introduced the Energy Conservation Act (ECA) in 2001. The Act proposed adherence energy norms for energy consumption for heavy consumers, developed Energy Conservation Building Code for new buildings, standards for performance in energy efficiency and also display of labels on appliances indicating their energy consumption. Under this, the organisation formulated to implement the provisions of this Act is Bureau of Energy Efficiency. This Act led to the energy savings of around 12 mtoe, saving around 4 GW of energy generation or an additonal investment of around 15-20 thousand crore rupees between 2007 and 2010. The strengthening and amendments in Act was done in 2010 (Tata Strategic, 2014).

In addition to this, National Action Plan on Climate Change (NAPCC) was launched in 2008. Under this, National Mission for Enhanced Energy Efficiency (NMEEE) came into picture.

One of the important initiatives promulgated under NMEEE is Perform, Achieve and Trade Scheme (PAT), under which most energy intensive units such as Thermal power plants, Steel, Cement, Aluminium, Chlor Alkali, Textiles, Pulp & Paper, Fertilizers (known as Designated Consumers) has been assigned energy efficiency improvement targets. This created Tradable Energy Savings Certificates (ESCerts) under PAT scheme. Firms unable to meet their target buy energy saving certificates from those who over-achieved the target, forming the PAT market.

PAT is a cost-effective mix of regulation in terms of mandatory energy saving targets along with formation of market for trading of these energy saving white certificates.

The results of Cycle-I of PAT as per BEE, 2017 is approx. 8 mtoe of energy savings though the target set was approx. 6 mtoe, an over achievement of around 30 percent, equivalent to approx. 9500 crore rupees of monetary savings.

Various other programs in order to achieve energy efficiency were launched such as market transformation for energy efficiency, energy efficiency financing platform.

These mechanisms aims at financing demand side management programmes for all sectors taking into consideration the future energy savings.

As highlighted by our discussion energy cost forms a huge proportion of total production cost in Indian industries and therefore it is also affecting its competitiveness and profitability. The most feasible and best method to reduce energy intensity of Industries is to implement energy efficiency practices. India has also made reasonable progress in implementing energy efficiency practices in India. The most prominent out of these are Energy Conservation Act (ECA), 2001 and Perform Achieve and Trade (PAT), 2012. As per Bureau of Energy Efficiency, PAT Cycle-I (2012-15) was successful and overachieved its target but there were few anomalies in the structure of the program and the targets being easily achievable (Bhandari, Shrimali, 2017) and also no clarification on the trading of ESCerts, oversupply of ESCerts due to easily achievable targets and hence low price of ESCerts in the market as per Hindu Business Line article, May 2018 and other reports and authors.

Thus our study focuses on studying whether these policy initiatives have any impact in reducing the energy intensity of Indian industries or not and their overall performance in terms of profitability, production and emissions by estimating energy intensity, profitability, production and emissions of these industries pre and post implementation of ECA and PAT Cycle-I.

CHAPTER 2

LITERATURE REVIEW

2.0 Literature Review

The literature survey has been summarised into various themes:

Identification of variables affecting the following:

(i) Profitability of firms
(ii) Emission intensity of firms
(iii) Energy intensity of firms

In order to identify variables impacting energy intensity, profitability and emission intensity for our study we have carried out an extensive literature survey.

i)The variables affecting **profitability** are identified as: energy intensity, labor intensity (manpower cost), raw materials cost (excluding fuels), number of workers, capital intensity, industry (dummy variable), exporting firm (dummy variable), foreign owned firm/ MNE Affiliation (dummy variable), ISO9000 certification (dummy variable), Firm size, Research & Development intensity, Age of the firm, Choice of fuel. Out of these the following variables have been selected for our study: energy intensity, labor intensity, capital intensity, firm size, age of the firm, technology import intensity, repairs intensity and PAT and ECA to account for policy intervention in dummy variable form.

Energy intensity is an important variable affecting profitability of industries as highlighted by many authors such as Cantore and Cali (2011), Sahu and Narayan (2014). It is also an important variable in terms of our business problem highlighting energy cost to be affecting profitability of energy-intensive industries. A positive relation of profitability with energy intensity has been found by various authors. For manufacturing industries, more energy efficient the industry more profitable it is, in most of the developing countries.

Labor intensity (manpower cost) is also a variable which can be connected to profitability of industries. This variable has also been used by Cantore and Cali (2011). Labor intensity is positively related to profitability. Raw materials cost (excluding fuels) and number of workers are also the related variables used by the same author in their analysis. The number of workers employed also affects profitability and raw materials cost (excluding fuels) is found to be negatively related to profitability.

Capital intensity is also a variable affecting profitability as per literature. Cantore and Cali (2011) and Sahu and Narayan (2014) found the domestic firms using natural gas as primary source of energy are more capital-intensive in comparison to firms using coal and oil.

The type of industry, exporting firm, MNE Affiliation (foreign or domestic), ISO9000 certification are used in the form of dummy variable by Cantore and Cali (2011) and Sahu and Narayan (2014). The relationship found in literature is as follows: when the certain firm level controls were added at firm-level such as age, number of workers, accounting for exporter and foreign ownership in the form of dummy variable, we found industry dummy does not affect profitability. The same result is also found for the variable exporting firm and ISO9000 certification but for MNE Affiliation, the results are different. The profitability of MNE affiliated firms those using coal as primary source is high in comparison to firms using petroleum and natural gas.

MNE Affiliated firms that use natural gas as primary source of energy their capital intensity is higher in comparison to firms using petroleum and natural gas. Energy intensity is minimum for the companies using natural gas and maximum for companies using coal the R & D intensity has the same behaviour for the domestic firms.

The other important variables affecting profitability are firm size, R & D intensity and age of the firm, choice of fuel used by authors Sahu and Narayan (2014), Al-Jafari and Samman (2015), Alahyari (2014), Sivathaasan et al. (2013), Mistry (2012), Bhayani (2010). Firm's size was found to be nonlinearly and directly related to profitability. Also been emphasized by various studies that size is an important variable affecting profitability. A direct relation was found between R & D intensity and profitability. By being less energy-intensive, firms using coal as primary source of energy are more profitable. A direct relation was found between firm's age and profitability. Due to the difference in primary source of firm's energy whether coal or petroleum or natural gas, their results with respect to profitability can vary.

ii) The variables affecting **emission intensity** are identified as: capital intensity, labor intensity, energy intensity, firm size, firm's age, technology import intensity, research and development intensity, multinational affiliation, regulatory intervention, choice of fuel/fuel mix, production/output. Out of these variables found in literature, the following variables are used for our analysis: energy intensity, firm size, firm's age, capital intensity, labor intensity, technology import intensity, repairs intensity, regulatory intervention (PAT and ECA) in dummy variable form.

As per literature, capital intensity is a variable affecting emissions intensity of industries. This variable has been used by Sahu and Narayan (2013), Nowogorska (2013), Kumar and Meena (2017) for their analysis. Emissions by a firm is positively related to capital intensity.

Labor intensity is also a variable affecting emissions by firms. This variable has been used by Sahu and Narayan (2013), Kumar and Meena (2017) for their analysis. The variable of labour intensity is found to indirectly affecting emission intensity and is significant at 1% level of significance.

One of the important variables affecting emissions intensity of industries is their energy intensity. This variable has been highlighted by many authors in their analysis namely Sahu and Narayan (2013), Kim and Worrell (2002), Nowogorska (2013), Kumar and Meena (2017). The relation between energy intensity and emission intensity is found to be significant and positive in literature.

Firm size is a variable affecting emission intensity of firms. This variable has been used by many authors for their analysis such as Sahu and Narayan (2013), Oak (2017), Nowogorska (2013), Kumar and Meena (2017). A significant and inverse relation was found between firm size and their emission intensity.

Another important variable affecting emission intensity of industries is age of the firm. This variable has been used by many authors in their analysis such as Sahu and Narayan (2013), Oak (2017), Nowogorska (2013), Kumar and Meena (2017). A direct relation is found between firm's age and emission intensity.

Technology import intensity is also a variable affecting emission intensity of firms. It is also highlighted by various authors in their analysis namely Sahu and Narayan (2013), Oak (2017), Nowogorska (2013), Kumar and Meena (2017). A direct relation was found between technology import intensity and emission intensity.

Research and Development intensity is a variable affecting emission intensity of firms. It has also been used by various authors in their analysis namely Sahu and Narayan (2013). A direct relation was found between R and D intensity and emission intensity.

Multinational Affiliation and Regulatory intervention are variables used in dummy variable form to be affecting emission intensity of firms. It has been highlighted by various authors in their analysis namely Sahu and Narayan (2014), Nowogorska (2013), Doonan et al. (2005).The variable MNE affiliation of firms was not found to be statistically significant. Investment in Rand D and technology imports are more by foreign firms and also better in terms of emissions than domestic firms. A major factor affecting environmental performance is regulatory intervention.

Other variables affecting emission intensity of firms are found to be Production/Output and Choice of fuel/Fuel mix. The various authors using these variables are Kim and Worrell (2002) and Nowogorska (2013). Changes in production level is also a factor affecting CO2 emissions. Fuel-mix determines the amount of pollution emitted.

iii) From the literature, the variables determining **energy intensity** are identified as: firm size, firm's age, export intensity, imports of finished goods intensity, raw materials import intensity, capital goods intensity, technology import intensity, research and development intensity/expenditure/dummy, IT use intensity, advertisement intensity, repairs intensity, foreign firm/MNE Affiliation (dummy variable), output-capital ratio, labor intensity, capital intensity, profit margin, firm dummy, industry dummy, energy prices/energy price elasticity/Wages. Out of these the following variables have been selected for our analysis: firm size, firm's age, technology import intensity, labor intensity, capital intensity, profit margin intensity, PAT and ECA in dummy variable form.

An important variable affecting energy intensity of industries is firm's size. This variable has been used by various authors namely Sahu and Narayan (2009, 2011), Goldar (2010), Kumar (2003), Oak (2017), Papadogonas et. al. (2007), Oczkowski and Sharma (2005), Faruq and Yi (2010), Haider et al. (2019). As concluded by various authors, the relationship between firm size and energy intensity was found to be non-linear as a U-shaped curve implying medium-sized firms to have less energy intensity in comparison to both very small and very large firms. A negative and significant coefficient representing firm size and a positive and significant coefficient representing square of firm size were found. For energy-intensive industries, firms of large size are not energy efficient. As stated by some authors the relationship between energy consumption and firm size is not very obvious. An inverse relationship between firm size and energy intensity was found by Kumar (2003) and Goldar (2010) whereas using a cross-sectional study Sahu and Narayan (2009) found an inverted U shaped relationship in 2008 and Sahu and Narayan (2010) then found a U-shaped relationship in 2009 using nine years data of pooled cross sectional data. Sahu and Narayan and Kumar did not strongly identify the benefit from economies of scale for large firms in terms of diminishing returns in use of energy. But as per Papadogonas et. al. (2007), firms with large size have energy cost advantage than low energy consuming industries.

The variable age of the firm as a determinant of energy intensity has been highlighted by many authors such as Sahu and Narayan (2009, 2011), Goldar (2010), Kumar (2003), Oak (2017), Papadogonas et. al. (2007), Oczkowski and Sharma (2005), Faruq and Yi (2010), Haider et al. (2019). Many authors found with age energy efficiency of industries will increase. Young firms are more energy intensive in comparison to old vintage firms. Age coefficient is positive and significant and the square of the age coefficient turned out to be significant and negative. Therefore, the relation between firm's age and energy intensity is an inverted U shape curve.

Few variables such as Import of finished goods intensity, Raw materials import intensity, Capital goods intensity are found to be affecting energy intensity by various authors such as Sahu and Narayan (2009, 2011), Goldar (2010), Oak (2017), Morikawa (2012). Captured by technology it is considered to be an important determinant. Firms having high capital intensity will also be more energy intensive.

Technology import intensity is an important variable affecting energy intensity of industries highlighted by many authors namely Sahu and Narayan (2009, 2011), Goldar (2010), Kumar (2003), Kumar (1987), Oak (2017). Imports of technology is an important determinant to decline in firm level energy intensity and it is represented by capital. Spillover effects from foreign firms to Indian firms can be seen for technology energy efficiency.

Research and Development intensity/Expenditure/dummy is also an important variable affecting energy intensity of industries. This variable has been used by many authors in their analysis in various forms (intensity, expenditure and dummy variable) namely Sahu and Narayan (2009, 2011), Vanden and Quan (2002), Goldar (2010), Kumar (2003), Kumar (1987), Vanden et. al. (2004), Papadogonas et. al. (2007). More the Research and Development intensity, more the energy intensity. R&D expenditure reduces energy intensity of firms. Captured by technology it is an important determinant. But in contradiction to this, there was no relation found between energy efficiency and R and D investment intensity and infact there was positive correlation found between energy intensity and R and D intensity (Kumar, 2003 and Sahu and Narayanan, 2009, 2010).

But when R and D is used as a dummy variable in the study by Goldar (2010), then an expected negative relationship between R and D and energy intensity was achieved. Also, highly technological industries have less energy intensity as derived by Papadogonas et. al. (2007).

Other variables affecting energy intensity are IT use intensity, advertisement intensity, repairs intensity, Output-capital ratio. These variables have been used by some authors in their analysis namely Sahu, Narayan (2009, 2011), Goldar (2010), Kumar (2003), Papadogonas et. al. (2007). The results are use of IT help in improving energy use efficiency, Coefficient of advertisement intensity is statistically significant and negative. This variable is stating technological differences among industries. Negative coefficient is a sign that ceteris paribus, for consumer goods industry particularly consumer durables energy intensity is lower. The relation between repairs intensity and energy intensity was fond to be positive. Capital-intensive firms and firms incurring high expenditure on repairs have high energy intensity. An inverse relation was found between capital-output ratio and energy intensity.

Other important variables affecting energy intensity are capital intensity and labor intensity. These variables are highlighted by various authors in their studies namely Sahu and Narayan (2009, 2011), Subrahmanya (2006), Dargay et. al (1983), Lachaal et. al (2005), Morikawa (2012), Kumar (2003), Oak (2017), Goldar (2010), Papadogonas et. al. (2007), A.Miketa (2001). The variable labor intensity was found to be insignificant and inversely related to energy intensity of firms implying high labor-intensive firms to be engaged in more energy-saving techniques. But this result is not of much importance as the variable was found to be insignificant. Since energy prices in market represents energy cost, so demand for energy is negatively related to rise in energy prices and directly related to rise in real wages. Capital intensive firms more energy intensive as the results suggest.

Another important variable affecting energy intensity and which is also very important from the point of view of our study is profit margin of firms. This variable has been used by Sahu and Narayan (2009, 2011) and Kumar (2003) in their analysis. The variable was found to be directly related with firms' energy intensity but statistically insignificant.

One more variable affecting energy intensity is Energy prices/Energy price elasticity/Wages. This variable has been used by many authors in their study namely Vanden, and Quan (2002), Andersen et al. (1998), Thomsen (2000), Dargay et. al (1983), Greening et al. (1998), Kumar (2003), Schurr (1982), Jorgenson (1984), Vanden et. al (2004), Gupta and Sengupta, (2011), Miketa (2001). For Chinese firms relative energy prices are affecting energy intensity. The range of Energy price elasticity lies between -0.10 and -0.35 for industrial sub-sectors, particularly for manufacturing sector it turned out to be -0.26. Also for Swedish Manufacturing industries relative changes in energy prices affects energy consumption/intensity. In Indian context, the energy consumption is very much affected by change in prices and not much affected in response to change in capital requirements. Change in price of energy is the main contributor to growth of factor productivity while contribution of technical change (price neutral component) remains minimal.

Certain variables affecting energy intensity are used in dummy variable form namely firm dummy, foreign dummy/MNE Affiliation. These variables are used by these authors Sahu, Narayan (2009, 2010, 2011), Goldar (2010), Kumar (2003). In comparison to domestic firms, MNE Affiliated/foreign-owned firms are lesser energy-intensive. There is more energy efficiency in case of firms with foreign ownership as highlighted by Kumar (2003), Sahu and Narayanan (2009) and Goldar (2010) but it is not the case in Sahu and Narayanan (2010). The environment regulation energy prices in a country effect the impact of foreign ownership/MNE Affiliation on energy consumption/intensity of industries.

Apart from this, other themes included are: (iv) Indian Scenario Industrial Energy Efficiency/ Energy Intensity in Indian Industries (v) Emission Intensity in Industries (vi) Industrial Energy Efficiency relation with profitability (vii) Industrial Energy Efficiency relation with productivity

Brief Literature Review under various other themes

iv) Energy Intensity in Indian Industries

As highlighted by many authors and reports, Energy intensity by Indian industries is high. There are few prominent types of Industries which are highly energy-intensive such as Iron and Steel, Fertilizer, Cement, Textiles, Chlor-Alkali, Aluminium, Pulp and Paper etc. and termed as Designated Consumers (DCs) under EC Act, 2001. In these industries, energy intensities are above the average energy intensity of all manufacturing industries in India. Also, energy intensity varies over time as well as over type of economic activity (Ray, 2011; IEA, 2009). In usual situation, industrial energy usage will rise more than rise in aggregate final energy use in India. Energy efficiency level is below world average. Decline in energy intensity can also lead to decline in emissions (IEA, 2009). There is variation in industrial energy efficiency across states, states with higher share of energy intensive industries have lesser energy efficiency (Mukherjee, 2008).

Lack of data limits the role energy efficiency could play in policy formulation in developing countries (Phylipsen, 2011).

There exists huge energy saving potential in steel, cement, aluminium sectors to as high as 17 percent in aluminium sector. Also, government interventions such as import duty exemptions, stricter emission standards will be of great help to cement industry in utilizing energy saving potential faster. Gaining energy efficiency will make Indian industries more cost effective and competitive in the world (Dutta and Mukherjee, 2010).

With gaining efficiency in technology, an average firm can reduce its energy input by about 14 percent and still producing the same quantity of output in all major states. Also, with existing technology and gaining technical efficiency, an average firm in all states can produce more output along with reducing energy input by about 4 percent (Mukherjee, 2010).

In Indian industries due to lack of information, production was given more importance and therefore energy efficiency measures focus on all the three – decreased consumption of energy, costs of production and costs of energy. (UNEP, 2006)

With decrease in energy intensity of GDP by 88 percent between 1980-2007 we can conclude that there has been tremendous improvement in our country on energy efficiency front.

It has been emphasized in the energy economics literature that energy efficiency may provide both monetary and non-monetary benefits and it has also been confirmed by many studies that energy efficiency may increase firms' profitability (UNIDO, 2011). Energy efficiency can also be described as the "first fuel", which every country possess in abundance and therefore good energy efficiency policies are very helpful in achieving goal of reducing climate change effects, air pollution, energy security and energy access (World Bank, 2016). One of the simplest means to tackle climate change, make the air clean, to make business more competitive and reduce energy costs is energy efficiency (UNIDO, 2011). Improving competitiveness in the market is a very important motive behind implementing energy efficiency measures by industries in European Union (ICF International, 2015).

Implementation of PAT mechanism in 2012, NMEEE and formation of BEE in 2008 and ECA in 2001 are the important policy initiatives undertaken by the Government for industrial energy efficiency. Market failure, cost involved and risk in implementing new technology remains the main barrier for industrial energy efficiency (Bhattacharya and Cropper, 2010). The additional targets should be set to tackle rising energy costs and appropriate well-defined goals to promote long term investment, promote a functioning PAT market platform (Shrimali and Bhandari, 2017). There are in efficiencies in the target setting for the thermal power sector under PAT. This sector has much more energy saving potential. If the full potential is met then alone thermal power sector could have achieved a surplus of around 5 million certificates (Sahoo, 2017). Market based incentives offer cost-effective efficiency gains (UNEP,2004).

Haider et al. (2019) studied energy efficiency of Indian paper industry using firm-level data from CMIE Prowess. There was no significant improvement in energy efficiency in this industry during 2003-04 to 2013-14.

As highlighted by many authors and reports, industrial energy efficiency has its own benefits, reduced input cost is also a benefit of energy efficiency along with reduction in CO2 emissions and increase in profitability.

The energy cost forming a huge component of total production cost across various industrial sectors namely iron and steel, fertilizer, cement, glass etc. has been highlighted by many reports and authors. As per Industrial Development Report 2011, in developing countries including India the percentage share of energy cost is 65 percent higher than in developed countries. The share of energy cost on average in an industry is around 10-20 percent of the total production cost but for an energy-intensive industry this can range from 20 to 50 percent. In case of energy-intensive industries, the energy saving potential ranges from 3 to 30 percent (UNIDO, 2010). About 20-30 percent of energy cost could be reduced by purchasing energy efficiency products and efficient management of facilities in iron and steel, fertilizer sector (PwC, 2010).

v) Emissions in Indian Industries

As highlighted by many authors, emission reduction is a benefit attached to energy efficiency in industries. Any kind of improvement or investment in energy efficiency practices will result in decline in greenhouse gases such as SO_X, NO_X and CO_2 etc.

As per IEA (2007), energy efficiency improvements will benefit in the form of energy security, increase in industry competitiveness and environmental benefits such as reduction in CO_2. Countries are under tremendous pressure to clean pollution from industry and limits its growth.

As per Business Line article dated December 6, 2018, among the highest carbon-dioxide emitting countries in the world, India ranked fourth after China, US and European Union. It accounts for 7% of global emissions in 2017. Of the aggregate GHG emissions in India, around one fourth emissions are contributed by industries. Industrial Emissions Grew 8.89 Percent Annually from 2005-2013 (Gupta and Biswas, 2017).

An increase in energy intensity leads higher emission intensity. Also, higher emission intensive industries are capital intensive and less emission intensive industries are labour-intensive. This leads to a question regarding use of technology in manufacturing industries particularly high emission intensive. Indian manufacturing sector doesn't support Environmental Kuznets Curve (Ranjan, 2015).

As per the literature we know that a long term relationship exists among CO_2 emissions, energy consumption, economics activity and trade. Several empirical results support that energy consumption drives economics activity in short run as well. More energy demand is associated with economics growth. Also, CO_2 emissions are the one way cause for energy consumption in short run and CO_2 emissions to economic growth (Srinivasan ,2014).

To study the trend of CO2 emissions in iron and steel industry in seven countries including both developed and industrialized countries like United States and developing countries like India, Brazil etc. Kim and Worrell (2002) carried out the decomposition analysis. They found out technology change in terms of policy change affects the development in energy intensity. Energy efficiency was found to be the most important factor behind decline in energy intensity in all countries and also increased or decreased production level affects emission intensities in most of the countries.

As per a study, from 2010 to 2030 for cement industry electricity savings and associated emissions reduction are 83 TWh and 82 Mt CO_2 respectively. Also, fuel savings and associated emissions reduction are 1029 PJ and 97 Mt CO_2 respectively. In Indian steel sector, from 2010 to 2030, electricity savings and associated emissions reduction are 66 TWh and 65 Mt CO_2 respectively. Also, fuel savings and associated emissions reduction are 768 PJ and 67 Mt CO_2 respectively. (Morrow et al., 2013).

The characteristics of firm like energy intensity, age, size plays an important role in the variation of energy intensity of companies. Further, it is also found that technology intensity, capital intensity, labor intensity are also responsible factors affecting CO_2 emission intensity of Indian manufacturing firms (Kumar and Meena, 2017)

Inter-firm energy and emission intensity differences are also found by Sahu and Mehta, 2015 in their study. They also found out that more energy intensive industries are also emission intensive.

It has been seen in the literature, both small and large sized companies are more energy intensive as well as emission intensive as compared to medium sized companies.

If India wants to generate the equal level of output as China generates, India would require double amount of energy it is currently using. Highest level of energy intensity in India is of Iron and steel and non-metallic minerals sectors (Pappas and Chalvatiz, 2016)

vi) Industrial Energy Efficiency relation with profitability of firms

There are many evidences showing a prominent effect of Industrial energy efficiency on its profitability and it is also highlighted by many authors through their work.

Sahu and Narayan (2014) studies the factors related to energy intensity and found that energy intensity and profitability are positively related for all the manufacturing companies including coal, petroleum as their primary source of energy except companies using natural gas. In other words, if we use natural gas it will help to increase the profitability.

Higher energy efficiency is always related with higher profitability for manufacturing industry. This is also true for majority of developing countries (UNIDO, 2011)

IPCC has given an estimate that energy consumption can be reduced by 10 %-30 % without an extra net costs to the company which directly indicate that energy efficiency can contribute to reduce the overall company cost.

(i) Relation between industrial energy efficiency and productivity of companies

Several authors have highlighted the relationship between energy efficiency and production or productivity of firms, also the other factors affecting energy efficiency. According to a study conducted by Sahu (2011) energy intensity and total factor productivity (TFP) are indirectly related i.e., energy efficient firms have greater TFP.

As per Sathaye (1998), during 1978-98, high demand for energy was moderated by their productivity growth in manufacturing industry. Increasing energy prices will have negative effect on productivity in Indian industries (Roy, 1999). A good understanding of rate and direction of technological change, change in energy prices, inter-fuel substitution is required for policy implication.

As per the study by Madheswaran (2010), during the period 1980-2005, energy consumption is directly related to output growth in Indian cement industry.

Productivity benefits of energy efficiency improvement must be included in economic assessment of the potential of energy efficiency improvement (Worrell, 2001). In small scale industries in India, link of energy intensity to productivity and profitability is prominent (Pal, 2006).

THEME WISE LITERATURE GAP

Theme 1 **: Indian Scenario Industrial Energy Efficiency/ Energy intensity in Indian Industries**

For theme 1, following are the gaps derived: i) Functional form of KLEM production function ii) Use of Energy as input in Cobb-Douglas production function iii) Correct and realistic assessment of Energy Efficiency iv) Understanding of Energy sufficiency (or conservation) and Energy efficiency vi) For the consequent absorption of energy-efficient technologies, understanding and disentangling market failure and non-market failure explanations vii) Energy Efficiency as a means for attaining sustainability viii) Relation of EKC with energy efficiency in firms ix) Explaining Dynamic Theory of Profit in terms of energy cost x) Policy interventions on Industrial Energy intensity xi) Energy intensity and economic activity in industrial sectors xii) Competitiveness of industries due to energy efficiency xiii) Fuel-mix in industries over the years xiv) Energy cost and performance of industries xv) Energy cost and firm level emission intensity xvi) Policy intervention and energy cost of industries

***Theme 2* : <u>Emission intensity in Industries</u>**

For theme 2 following are the research gaps identified: i) Emission reduction linkage with energy intensity of industries ii) Policy invention in emission intensity of energy intensive industries

***Theme 3*: <u>Industrial Energy Efficiency relation with Profitability</u>**

For theme 3 following are the research gaps identified: i) Energy intensity, emission intensity and profitability ii) Energy intensity as energy consumption per unit of output/production and Energy intensity as per unit of Net Sales iii) Policy interventions on profitability of industries

***Theme 4*: <u>Industrial Energy Efficiency relation with Productivity</u>**

For theme 4 following are the research gaps identified: i) Impact of industrial policy interventions on productivity ii) Accounting for change in productivity of industries using Cobb-Douglas production form

GAPS IDENTIFIED FOR THIS STUDY

After extensive theme-wise literature survey above we have identified many gaps in the literature. But this thesis deals with the following gaps (i) functional form of KLEM production function is not known (ii) using energy as input in Cobb-Douglas production function (iii) impact of policy intervention on industrial energy efficiency (iv) policy intervention impact on profitability of industries (v) linkage among energy intensity and profitability of industries, production and emission intensity of industries (iv) policy intervention and its impact on production and emission intensity of industries (vi) relationship between energy intensity, profitability and emission intensity of industries.

Since Indian government is making a lot of efforts to reduce emissions in the economy, one of the best ways to reduce it is through reducing the energy intensity of Indian industries. Also, as identified by various authors energy intensity also affects profitability of firms, our study revolves around studying the impact of two important policy interventions namely, ECA, 2001 and PAT mechanism Cycle –I (2012-2015) on energy intensity, profitability, production and emission intensity of industries. Also, gaining energy efficiency consequently reducing energy intensity of all economic processes is an important objective of all policy initiatives in the Indian economy.

Concluding Remarks

After extensive literature review the overarching research questions which arises are what is the impact on energy intensity of Indian industries due to implementation of policy initiatives, ECA and PAT? What is the impact on profitability and production of Indian industries? What is the corresponding level of emissions pre and post policy intervention period? What is the impact of these policy initiatives on emissions?

Our thesis is an attempt to answer these questions in context of Indian economy/industries.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Business Problem

As highlighted by many reports and also very obvious from the facts above that as energy cost forms a huge proportion of total production cost in Indian industries, investing in energy efficiency measures and reducing energy intensity will also be helpful in increasing industry profits and thereby competitiveness.

This relation between reducing energy intensity and increasing profits is also highlighted by many reports and authors. According to World Steel Association, due to energy efficiency improvements there is decline in total production cost and hence improved competitiveness. As per UNIDO 2011, it has been emphasized in the energy economics literature that energy efficiency may provide both monetary and non-monetary benefits and it has also be confirmed by many studies that energy efficiency may increase firms' profitability.

Industrial Development Report, 2011 highlighted that one of the easiest ways to tackle climate change, make the air we breathe clean, improve business competitiveness and reduce energy costs is energy efficiency. As per ASSOCHAM report 2009, the high energy costs is killing the competitiveness of Indian industries such as aluminium. The share of energy component has reached around 40 percent in the manufacturing sector. Thus energy cost is a significant component of India's industrial performance.

According to Australian Government, Department of Industry 2014 report, particularly in metals industry their energy cost is equal or sometimes even greater than companies' EBITDA which is a standard measure of profitability in accountancy. A 5 percent increase in these companies' EBITDA is possible by implementing energy efficiency practices. Practising energy efficiency in highly impacted companies will help reduce energy costs by about half an average.

Therefore, competitiveness of the companies' are also affected in terms of their reduced profitability with energy cost forming high proportion of their production cost.

3.1 Research Gap

From the literature review we could not find any study in context of India which talks about the impact of policy intervention particularly Energy Conservation Act (ECA), 2001 and PAT Cycle-I on energy intensity, profitability, production and emission intensity of energy intensive industries. Energy-intensive industries consume around 60 percent of total industrial energy consumption in India therefore, it is very important to study whether these policy initiatives are seriously impacting energy intensity of industries or the results are just on paper not in reality. Also, energy efficiency increases profitability of industries and reduces emissions which is most important objective of Indian government these days.

The gaps identified from literature are (i) functional form of KLEM production function is not known (ii) using energy as input in Cobb-Douglas production function (iii) impact of policy intervention on industrial energy efficiency (iv) policy intervention impact on profitability of industries (v) energy intensity, profitability, production and emission intensity of industries (iv) policy intervention impact on production and emission intensity of industries (vi) energy intensity, profitability and emission intensity of industries.

3.2 Research Problem

From the research gaps we reach our research problem that there is dearth of understanding of impact of policy interventions on energy intensity, profitability, production and emission intensity of energy-intensive industries in India.

Policy intervention and Energy cost are the two important variables have not been studied in traditional Cobb-Douglas production function as of now. Therefore, the problem is how to revise the traditional production function in a way such that these two variables can play important role along with the traditional variables viz., labor and capital in estimating output, profitability, emission and energy intensity in an empirical framework. The basic problem here is to know what could be the possible impact of policy intervention and energy cost when both will be entered into the production function as input variables.

Our study aims to study the impact of two important policy initiatives/interventions ECA, 2001 and PAT Cycle-I (2012-15) on overall performance of energy-intensive industries in terms of energy intensity, profitability, production and emission intensity.

3.3 Research Questions

We have identified the research gaps and from those gaps we have formulated the research questions as follows:

(i) What is the impact on energy intensity of selected industries during pre and post policy intervention period?

(ii) What is the impact of energy cost and policy intervention on profitability and production of selected industries?

(iii) What is the corresponding level of emissions pre and post policy intervention period?

3.4 Research Objectives

Following are the research objectives:

RO1 : To study the energy intensity of energy intensive industries during pre and post policy intervention period

RO2 : To study the impact of energy cost and policy intervention on profitability and production of selected industries

RO3 : To study the emission intensity of selected industries during pre and post policy intervention period

3.5 Theoretical Underpinning

The following theory are the basis of this research :

KLEM Production function can form a part of theoretical background for our study as this production function suggests E (Energy input) to be an important factor of production along with K (Capital), L (Labor) and M (Materials) input.

K.E. Bounding has criticized the traditional model as being similar to the medieval elements of earth, air, fire and water. He suggests that know-how, energy and materials might be a more appropriate set of inputs. However, the more popular model is called KLEM Model, which recognizes Capital (K), Labor (L), Energy (E) and Materials (M) as factors of production which are indispensable to any productive activity.

Profitability of companies/industries can be increased by either increasing revenue or reducing the cost of production where our study will define a means of increasing profitability by reducing energy cost.

As can be seen by KLEM Model, Energy is also an important factor determining production of industries.

Cobb-Douglas Production Function: The standard production function given by Cobb-Douglas considering the only two factors of production is:

$$Y = AL^{\alpha}K^{\beta}$$

where,

Y = aggregate production of the good

L = number of labor hours used in production of good

K = capital goods used

A = total factor productivity, more the value of A more efficient the firm is

α and β are constants (as per the available technology) which are considered as output elasticities of labor and capital respectively.

<u>Contribution to Theory</u>

- We will be adding Cobb-Douglas (CD) production function specification to KLEM Model i.e., specifying KLEM Model in terms Cobb-Douglas form.

- Advantage of CD production function ;

a. Become linear after taking natural log

b. Can be estimated using econometric tools

c. Applicable in energy intensive industries

In addition to KLEM form, The Dynamic Theory of Profit stating dynamic changes in production process (quantum of capital invested, methods of production, managerial organisation, technology, demand pattern etc.) affects profits and profit is the difference between the price and the cost of the production of the commodity. Cost of production also includes Energy Cost.

For Emissions, Environmental Kuznets Curve can be applied at firm level, implying as the firm progresses in terms of energy efficiency in production, it will have effect on its emissions as well.

We can also relate Structure-Conduct-Performance paradigm to our study. Structure-Conduct-Performance paradigm relates to markets in Industrial Economics. This paradigm was first published by economists Edward Chamberlin and Joan Robinson in 1933. A model in Industrial Organization Economics was developed by Joe S. Bain defining a casual theoretical explanation for firm performance through economic conduct/structure and environment in which the firm is operating.

According to the structure–conduct–performance paradigm, the market environment has a direct, short-term impact on the market structure, the environment in which the firm is operating. The market structure, economic environment then has a direct influence on the firm's economic conduct, which in turn affects its market performance. Then, feedback effects may also occur such that market performance of the firm may impact conduct and structure, or conduct may affect the market structure. Additionally, external factors such as legal or political or policy interventions affect the market framework/environment and thereby affecting the structure, conduct and performance of the firms in the market (Faccarello and Kurz).

This paradigm is related to our study in the sense that we are trying to find out the impact of policy environment, their specific characteristics/structure of firms in energy-intensive industries in India on their market performance in terms of their energy intensity, profitability, production and emission intensity.

3.6 Research Methodology

The proposed study will be based on secondary data collected from CMIE Prowess Database and will be using Multiple Regression technique with dummy variables as tool of Analysis.

3.6.1 Identification of Industries

Eight energy-intensive sectors are covered under PAT Mechanism, Cycle-I (2012-15) namely,

- Aluminum
- Cement
- Chlor-Alkali
- Fertilizers
- Iron & Steel
- Pulp & Paper
- Textiles
- Thermal Power Plants

i) Aluminium sector

The second most important metallurgical industry in India is the Aluminium industry. It is mainly dominated by companies such as Hindalco and Vedanta, which are privately owned by NALCO. The second most important metal industry is aluminium and meet the needs of a wide arena of industries mainly electronics and electrical, automobile and its components, engineering, infrastructure, packaging etc. About 10% of bauxite reserves of the world are in India.

In aluminium sector the threshold limit is 7500 toe to become a designated consumer. Ten designated consumers have been identified under PAT Cycle-I in states of Odisha, Karnataka, Jharkhand, Chhattisgarh, Maharashtra and Uttar Pradesh.

Under PAT Cycle-I, the achieved savings for aluminium sector is 0.730 million toe, nearly 60 percent higher than target set, An investment of 140 crores have been made by the designated consumers to achieve this target.

ii) Textile sector

The contribution of textile industry to total industry output is around seven percent (in value terms) in 2018-19. Around two percent of GDP is contributed by the textile sector and it provides employment to around 45 million people in 2018-19. Also, it contributed around 15 percent of the export earnings of India during the same period.

The textile sector in India is predominantly cotton based cotton based with about 65 percent of fabric consumption in the country being accounted for by cotton. In Textile sector, the threshold limit of energy consumption to become a designated consumer is 3000 toe per annum. In PAT cycle-I, 90 designated consumers have been identified from various states.

The energy consumption savings achieved by the sector is 0.129 million toe which is 95 percent higher than their savings target set.

iii) Thermal Power Plant sector

Thermal power plant sector is one of the most energy intensive sector accounting for nearly 46 percent of the energy savings targets under PAT Cycle-I. The threshold limit for thermal power plants is 30000 toe which covers almost 86.6 percent of the installed thermal power generation capacity in 2011. This covers coal, gas and diesel fired thermal power plants, of which coal fired power plants contributing highest 86.5-97 percent in terms of capacity, followed by gas (12.71-40 percent) and then diesel (0.71-7 percent).

In PAT Cycle-I, this sector achieved a target of 3.06 mtoe, a shortfall of 5 percent from the assigned target. Around 13 million tonnes of CO2 emissions have been reduced.

iv) Cement sector

Indian cement industry is one of the highly energy-intensive sector as coal and electricity are the two major energy inputs in this industry. India is second largest producer of cement in the world as well as consumer in the world due to growth of infrastructure and construction sector in last two decades. It is providing employment to more than a million people directly or indirectly. The threshold limit to become a designated consumer under cement sector is 30000 toe of energy consumed per annum. A total of 85 designated consumers from various states were identified and assigned targets under PAT Cycle-I.

The cement sector achieved a savings of 1.48 mtoe, around 81.6 percent higher than the assigned target for 85 DCs.

v) Chlor-Alkali sector

The Chlor-Alkali sector in India is 3.3 million in size which is 4 percent of the world market. The threshold limit is 12000 toe per annum for the chlor-alkali sector. A total of 22 designated consumers across the country were assigned targets.

At the end of PAT Cycle-I, energy savings is around 0.093 mtoe, around 72 percent higher than the target.

vi) Pulp and Paper sector

Around 3 percent of the production of paper in the world comes from Indian pulp and paper industry. On the basis of raw materials usage this sector has been categorized namely, wood based, agro based, recycled fibre and 100 percent market based pulp. Around 31 percent of paper production is wood based, 22 percent is from agro residues and 47 percent is from recycled/waste paper. 31 designated consumers were assigned targets under PAT Cycle-I.

The achieved energy savings for pulp and paper sector is 0.289 mtoe, which is around 143 percent higher than the assigned target.

vii) Iron and steel sector

One of the most energy-intensive sectors is the Iron and Steel sector which consumes 25% of the total energy consumption (IEA, 2012). Energy consumption in Indian steel plants is high in comparison to world average as well mainly due to obsolete technology but it is gradually improving (Ministry of Steel, 2017). The Indian Iron and Steel sector contributed to about 28 percent of the emissions by the industrial sector in 2007. (Krishnan et al., 2013)

As per Worldsteel Association, in 2016, India ranked third in terms of steel production after China and Japan. The steel sector contribution to India's GDP is approximately 2 percent in 2015-16 (Ministry of Steel, GoI, 2016).

Under PAT Cycle-I, the threshold limit for Iron and Steel sector is 30000 toe per annum. A total of 67 designated consumers were assigned energy saving targets under this. The achieved savings by this sector is 2.10 mtoe which is around 41 percent higher than the assigned target.

viii) Fertilizer sector

India stands second as fertilizer producer and third as fertilizer consumer in the world. This industry is world class in terms of plant size, efficiency level and technology used. (Bureau of Energy Efficiency,2015)

India produces about 22 mt urea per year. The energy cost accounts for 80 per cent of the cost of urea production in India. Therefore, survival of the industry depends on improvement in energy efficiency. (Mukundan, 2014)

Under PAT Cycle-I, the threshold limit is 30000 toe per annum to become a designated consumer. A total of 29 designated consumers were identified under this. The achieved level of energy savings stands at 0.78 mtoe, which is around 64 percent higher than the assigned target.

All the eight sectors have been included for analysis in this study.

Under PAT, plants of various companies have been included but since plant level data is not available, we have taken firm level data (company level data) for our analysis.

Based on their energy consumption to be called a Designated Consumer under PAT, these sectors are divided into two datasets based on PAT Booklet, Ministry of Power, Government of India, July, 2012. This also needs to be done to overcome the problem of availability of data only for few companies covered under PAT on CMIE Prowess.

Table 3.1 : Classification into two Data Sets

	Minimum Annual Energy Consumption for the Designated Consumers (tonnes of oil equivalent)	Companies	Number of Companies Taken for Analysis
DATA SET 1	3000 – 29000	Aluminium Chlor-Alkali Textiles	26
DATA SET 2	30000 and Above	Cement Pulp and Paper Thermal Power Plant Fertilizer Iron and steel	62

Table 3.2 : Companies included under each sector in our study and are also covered under PAT Cycle-I

Sector	Companies
CEMENT	Chettinad Cement Corpn. Pvt. Ltd. Gujarat Sidhee Cement Ltd. Heidelberg Cement India Ltd. India Cements Ltd.

	J K Lakshmi Cement Ltd. Kalyanpur Cements Ltd. K C P Ltd. Malabar Cements Ltd. Mangalam Cement Ltd. O C L India Ltd. Panyam Cements & Mineral Inds. Ltd. Sanghi Industries Ltd. Saurashtra Cement Ltd. Shree Cement Ltd. Shree Digvijay Cement Co. Ltd.
IRON AND STEEL	Bhushan Steel Ltd. Essar Steel Rashtriya Ispat Nigam Ltd. Steel Authority of India Ltd. Tata Sponge Iron Ltd. Tata Steel Ltd. Welspun Corp Ltd. Aarti Steels Ltd. Balasore Alloys Ltd. Hira Ferro Alloys Ltd. J S W Ispat Steel Ltd. [Merged] Monnet Ispat & Energy Ltd. Orissa Sponge Iron & Steel Ltd. Sunflag Iron & Steel Co. Ltd. Usha Martin Ltd. Bhilai Engineering Corpn. Ltd. Mukand Ltd. Sharda Ispat Ltd.
ALUMINIUM	Bharat Aluminium Company Ltd. Hindalco Industries Ltd. National Aluminium Company Ltd.
TEXTILES	Alok Industries Ltd. Bombay Dyeing & Mfg. Co. Ltd. D C M Ltd. Grasim Industries Ltd. Loyal Textile Mills Ltd. Mafatlal Industries Ltd. Raymond Ltd. Suryalakshmi Cotton Mills Ltd. Vardhman Holdings Ltd. Vardhman Textiles Ltd.

CHLOR-ALKALI	Aditya Birla Chemicals (India) Ltd. [Merged] Aditya Birla Nuvo Ltd. [Merged] Chemplast Sanmar Ltd. D C M Shriram Ltd. D C W Ltd. Gujarat Alkalies & Chemicals Ltd. Gujarat Fluorochemicals Ltd. Kanoria Chemicals & Inds. Ltd. Punjab Alkalies & Chemicals Ltd. Reliance Industries Ltd. Sree Rayalaseema Alkalies & Allied Chemicals Ltd. Travancore Cochin Chemicals Ltd. U P L Ltd.
PULP AND PAPER	Ballarpur Industries Ltd. International Paper A P P M Ltd. J K Paper Ltd. Orient Paper & Industries Ltd. Seshasayee Paper and Boards Limited Star Paper Mills Ltd. Tamil Nadu Newsprint & Papers Ltd. West Coast Paper Mills Ltd.
THERMAL POWER PLANTS	NTPC Ltd. North Eastern Electric Power Corpn. Ltd. C E S C Ltd. N L C India Ltd. T C P Ltd. Gujarat Mineral Devp. Corpn. Ltd. Madras Aluminium Co. Ltd. [Merged] Odisha Power Generation Corpn. Ltd. Reliance Infrastructure Ltd. Tata Power Co. Ltd.
FERTILIZER	Chambal Fertilisers & Chemicals Ltd. Fertilizers & Chemicals Travancore Ltd. (FACT) Gujarat Narmada Valley Fertilizers & Chemicals Ltd. (GNFC) Gujarat State Fertilizers & Chemicals Ltd. Indian Farmers Fertiliser Co-Op. Ltd. Madras Fertilizers Ltd. (MFL) Mangalore Chemicals & Fertilizers Ltd. (MFCL) Tata Chemicals Ltd. National Fertilizers Ltd. (NFL) Rashtriya Chemicals & Fertilizers Ltd. (RCF) Zuari Global Ltd.

Source: Author's Compilation

3.6.2 <u>Identification of time period</u>

The following energy efficiency policies have been implemented by Government of India from time to time:

Energy Conservation Act, 2001 (ECA)

In order to reduce energy consumption and promote energy efficiency in the country, Ministry of Power launched the Energy Conservation Act in March 2002. The Act proposed adherence energy norms for energy consumption for heavy consumers, developed new Energy Conservation Building Code for new buildings, efficient energy performance standards and also display of energy consumption labels on appliances. Under this Act, Bureau of Energy Efficiency (BEE) was formulated to implement provisions defined by the Act. This led to the savings of 12.15 Mtoe or 18,875 Million kWh of electricity which is equivalent to electricity generated ~4 GW of generation capacity or ~INR 15,000 – 20,000 Cr worth of additional investment between 2007 and 2010. The act was amended and strengthened in 2010 (Tata Strategic, 2014).

<u>Initiatives to promote Energy Conservation and Energy Efficiency under this:</u>

a) Standards and Labelling by Bureau of Energy Efficiency

This scheme was initiated by BEE for equipments and appliances in 2006 in order to provide an informed choice to consumers about energy savings. It intends to reduce energy consumption by appliances without reducing its service to the consumers.

b) Energy Conservation Building Codes (ECBC) by Ministry of Power

Ministry of Power launched ECBC in 2007 for commercial buildings setting minimum energy standards for commercial buildings. It was updated in 2017 deciding new parameters. It aims to optimise energy savings and promotes cost-effectiveness over life-cycle in order to achieve neutrality in commercial buildings as well as keeping in mind comfort level of occupants.

c) Demand Side Management (DSM) Scheme

DSM interventions have helped utilities in reducing peak electricity demand but also save huge investments in generation, transmission and distribution networks.

Agriculture DSM (AgDSM)

This programme aims to reduce energy consumption in the agriculture sector by demand side management by means of reducing power consumption, efficiency in ground water extraction, investment in power plants through avoided capacity, reducing subsidy burden on state utilities.

Municipal DSM (MuDSM)

It aims at improving overall energy efficiency in the municipal bodies thereby leading to reduction in their electricity consumption and cost savings.

Capacity Building of DISCOMs

This programme aims at capacity building of DISCOMs in order to promote energy conservation and reduce peak electricity demand so that they can delay building further capacity.

Energy Efficiency in Small and Medium Enterprises (SMEs) sector

'National Programme on Energy Efficiency and Technology Up gradation of MSMEs' was flagged by BEE in 2007 to highlight the role of MSMEs in promoting energy efficiency. One of the major hurdle for MSMEs to implement energy conservation measures and energy efficient technologies is lack of access to finance.

Due to continuous efforts, MSMEs have started shifting from cost and quality approach to energy efficiency, no waste and reduced carbon emissions approach.

d) Strengthening of State Designated Agency (SDAs)

All State Governments/UTs are supposed to have a State Designated Agency (SDA) to enforce the provisions of ECA, 2001.

Also, BEE provides financial assistance to SDAs to implement, coordinate, regulate, enforce energy efficiency measures and conservation in their states and also for contribution to State Energy Conservation Fund (SECF)

e) School Education Program by Bureau of Energy Efficiency

Awareness about energy efficiency and energy conservation needs to be created among the younger generation. For this, energy efficiency promotion and awareness is created under Energy Clubs in schools.

BEE prepared text/material on energy efficiency and conservation proposed to be incorporated in science syllabi and textbooks of NCERT for classes VI to X.

f) Human Resource Development (HRD)

Awareness creation is must for penetration of energy efficiency processes and equipments in the system. It could be done through policy of creation, retention and up gradation of human resource skills. It comprises of providing Energy Audit Instrument Support and theory cum practice oriented training programme to the citizens.

g) Promotion of Energy Efficient LED Bulbs – UJALA scheme

UJALA scheme aims to promote efficient use of energy at the residential level, using energy efficient appliances and promoting use of LED lights in houses. This scheme was initially called as DELP (Domestic Efficient Lighting Program) and was re launched as UJALA.

h) Promotion of Electric vehicle: – National Electric Mobility Mission Plan (NEMMP)

The government of India launched the *National Electric Mobility Mission Plan (NEMMP)* 2020 in 2013. The objective is to achieve fuel security by encouraging use of electric vehicles in the country. Its target is to achieve 6-7 million sales of electric vehicles per year from 2020 onwards.

i) *National Mission for Enhanced Energy Efficiency (NMEEE) under NAPCC*

The National Mission for Enhanced Energy Efficiency (NMEEE) is one of the eight missions under the National Action Plan on Climate Change (NAPCC). It aims to strengthen the market for energy efficiency creating new policy regime, fostering innovative and sustainable business models for energy efficiency.

Under this, four initiatives came into existence:

- *Market Transformation for Energy Efficiency (MTEE):*

Under MTEE, two programmes have been developed i.e. Bachat Lamp Yojana(BLY) and Super-Efficient Equipment Programme (SEEP). The aim is to accelerate shift towards energy efficient appliances.

- *Energy Efficiency Financing Platform (EEFP):*

The aim is capacity building of stakeholders related to Energy Efficiency financing.

- *Framework for Energy Efficient Economic Development (FEEED):*

This is for development of fiscal instruments to promote energy efficiency. Under this two initiatives are taken:

Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE): it provides commercial banks with partial risk coverage as they extend for energy efficiency prjects.

The Venture Capital Fund for Energy Efficiency (VCFEE): it provides equity capital to Government buildings and municipalities to fund energy efficiency projects**.**

- ***Perform, Achieve and Trade Scheme (PAT):***

The National Action Plan on Climate Change (NAPCC) was launched in 2008. Under this, National Mission for Enhanced Energy Efficiency (NMEEE) came into picture.

One of the important initiatives promulgated under NMEEE is Perform Achieve and Trade scheme, under which most energy intensive units such as Thermal power plants, Steel, Cement, Aluminium, Chlor Alkali, Textiles, Pulp & Paper, Fertilizers (known as Designated Consumers) has been assigned energy efficiency improvement targets. This created Tradable Energy Savings Certificates (ESCerts) under PAT scheme. Firms unable to meet their target buy energy saving certificates from those who over-achieved the target, forming the PAT market.

PAT is a cost-effective mix of regulation in terms of mandatory energy saving targets along with formation of market for trading of these energy saving white certificates.

As per the BEE-2017 report, for first cycle of PAT target was 6.68 mote but it achieved an energy saving of 8.68 mote which is approximately 30% more than the desired level of achievement consequently, it saved approximately 9500 Crores rupees in monetary terms.

As Energy Conservation Act, 2001 is about reducing energy intensity in the whole Indian economy. It aims at reducing energy consumption of all economic processes in the economy. In contrast to this, Perform, Achieve and Trade Mechanism target only at reducing Industrial energy intensity in the economy.

Therefore, the time period selected for the study is **1995-2015** because it will help us to study the impact of various energy efficiency policies on energy intensity, profitability and emission intensity of industries, pre and post implementation of both ECA, 2001 and PAT Cycle-I.

3.6.3 <u>Identification of variables</u>

From the extensive literature review in the last chapter we have found the following variables to be most suitable and important variables for our study.

For each company/firm following variables are considered as per literature :

i. *Energy intensity*
ii. *Profit Margin intensity*
iii. *Labor intensity*
iv. *Capital intensity*
v. *Age of the firm*
vi. *Size of the firm*
vii. *Repairs intensity*
viii. *Technology import intensity*
ix. *Carbon emission intensity at firm level are calculated using UK Government GHG Conversion Factors for Company Reporting, 2016, Department of Energy and Climate Change (DECC). The following formula is used :*

$$Emissions\ on\ GHG = Activity\ Data\ \times Emission\ Conversion\ Factor$$

$$Total\ Emissions\ (K_g\ CO_2e) = Energy\ Consumption\ \times Emission\ Factor$$

The variables affecting **Energy intensity** of firms are taken to be :

i) Profits Margin intensity

ii) Capital Intensity

iii) Labor intensity
iv) Firm size
v) Age of the firm
vi) Technology import intensity
vii) Repairs Intensity
viii) Dummy Variable : PAT
ix) Energy Conservation Act (ECA) in dummy variable form

The variables affecting **Profitability of firms** are taken to be :

i) Energy intensity
ii) Capital Intensity
iii) Labor intensity
iv) Firm size
v) Age of the firm
vi) Technology import intensity
vii) Repairs Intensity
viii) Perform, Achieve and Trade (PAT) in dummy variable form
ix) Energy Conservation Act (ECA) in dummy variable form

The variables affecting **Emission intensity** of firms:

i) Profits Margin intensity
ii) Capital Intensity
iii) Labor intensity
iv) Firm size
v) Age of the firm
vi) Technology import intensity
vii) Repairs Intensity
viii) Perform, Achieve and Trade (PAT) in dummy variable form
ix) Energy Conservation Act (ECA) in dummy variable form

To study impact on **production of firms** we have taken variables as :

i) Energy Expenses
ii) Profits

iii) Capital Expenses

iv) Labor Expenses

v) Age of the firm

vi) Technology imports

vii) Repair Expenses

viii) Perform, Achieve and Trade (PAT) in dummy variable form

ix) Energy Conservation Act (ECA) in dummy variable form

The variables for production as dependent variable we cannot have production in denominator of each independent variable to calculate respective intensity form for each of them otherwise our analysis will not be valid and give inappropriate results.

3.6.4 <u>Definition of Variables</u>

For our whole analysis "Sales" is taken as a proxy for "Production" due to unavailability of data as also used by many other authors in their study namely, Soni and Kapshe (2017), Oak (2017), Sahu and Narayan (2009, 2011, 2014), Goldar (2010), Kumar (2003), UNIDO (2010,2011).

The variables (based on the availability of data) are defined as follows :

Table 3.3: Definition of variables

Variable	Defined as
Profitability/Profit margin Intensity	Profit After Tax to Sales
Energy Intensity	Ratio of Power and Fuel Expenses to Sales
Labor intensity	Wages and Salaries to Sales
Capital intensity	Net Fixed Assets as a proportion of Sales
Firm Size	Sales and Assets in last three years
Repairs Intensity	Ratio of Repairs on Plant and Machinery Expenditure to Sales
Technology Import intensity	(sum of foreign exchange spent on capital goods, royalties, raw materials and technical-know how paid by the companies to foreign collaborations) / Sales
Age of the firm	Current Year – Year of Incorporation
Emission Intensity	Total Emissions to Sales

To study impact on **production of firms** the variables are defined as :

Table 3.4: Definition of variables (impact on production)

Variable	Defined as
Profits	Profit After Tax

Energy Expenses	Power and Fuel Expenses
Labor Expenses	Wages and Salaries of employees
Capital Expenses	Net Fixed Assets
Repairs Expenses	Repairs on Plant and Machinery Expenditure
Technology Imports	(sum of foreign exchange spent on capital goods, royalties, raw materials and technical-how paid by the companies to foreign collaborations)
Age of the firm	Current Year – Year of Incorporation

All the variables except Total Emissions (Kg CO_2e) and Age (in years) are in Rs. Million (as extracted from CMIE Prowess). Therefore, in order to correct it for Inflation we have used Index of Industrial Production (IIP) data from Indiastat.com and used the following formula to correct for Inflation :

(Current value of variable/IIP) x 100

3.6.5 Tools of Analysis Used

The main tool used in our complete analysis is "Multiple Regression Analysis with Dummy Variables".

An adjunct of simple linear regression is Multiple regression analysis in which by means of fitting a linear equation to the data we try to establish a relation two or more independent and the dependent variables.

The data selected for our study is a panel data (a data distributed over time as well as companies/firms). Therefore, the tool used in our study could also be called as "Panel data analysis". Here we considered fixed effect models and random effect models for panel data analysis.

Panel data models are of two types, Fixed Effect and Random Effect Models.

A dummy variable is known by several names such as Bernoulli variable, dichotomous variable or binary variable but all means the same thing that it can take only two values that is 0 or 1 which may be interpreted as "absence" or "presence" of any characteristics or attribute. A dummy variable are generally used in statistics, econometrics and data analytics field. In terms of set theory dummy variable can be used to segregate two attributes into mutually exclusive categories.

A regression model including both quantitative and qualitative variable (dummy variable) can be represented as:

$$Y_i = \alpha_1 + \alpha_2 D_{2i} + \alpha_3 D_{3i} + \alpha_4 X_i + U_i$$

Where, variables have their usual meaning:

Y_i = explained variable such as energy intensity of firms

X_i = quantitative variable such as profits of firms

D_{2i} = a dummy variable such as representing policy initiative; taking value 1, if ECA (Energy Conservation Act) is present

D_{2i} = 0, otherwise

D_{3i} = another dummy variable such as representing policy initiative; taking value 1, if PAT is present.

D_{3i} = 0, otherwise

U_i = error term

There are four important models which can be applied to our Panel dataset namely,

- In case we just wish to study the impact of variables that varies with time we use **fixed-effects model**. The fixed-effects model are capable of controlling for all characteristics of individuals that do not vary over time (such as gender, culture, race, religion, etc.) in order to get estimated coefficients of the model which are free of any biasness due to omission of these time-invariant characteristics.

- In case there is any reason to believe that some individual characteristics may impact the independent or the dependent variable means when we suppose to have some correlation between error term of the entity and the independent variable we use FE model. It eliminates the effect of all these characteristics that do not vary over time so that we can assess the impact of independent variable correctly on dependent variable.

  Fixed effect model equation is represented by:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + u_{it}$$

Where, notations have their usual meaning:

αi: the intercept term which is unknown specifying entity intercepts (i= 1 to n)

- The variations of entities are random in nature and uncorrelated with the explanatory variables is the assumption of the random effect model considered here.

  It is defined as:

$$Y_{it} = \beta X_{it} + \alpha + u_{it} + \varepsilon_{it}$$

  where, $u_{it} = error\ terms\ between\ the\ entities$

  $\varepsilon_{it} = error\ terms\ within\ the\ entities$

- In case there is any possibility of entity specific characteristics to effect dependent variable then RE model is used. In RE model, time independent variables like race, caste, gender etc. can be included in the model though FE model accounts for these in the intercept model. As per its nature, this model assumes that the error terms of entity are uncorrelated with explanatory variables used, therefore these time-invariant variables can be included as independent variables in the model itself.

- **Pooled Ordinary Least Square** assumes no entity specific characteristics, no panel effects. It is simple OLS estimation run on panel data. No individual specific characteristics are accounted for in this model.

- If there is some correlation between the error terms in a regression model then, OLS and weighted least squares may give misleading results in estimation of the parameters, in such a case, Generalized least squares (GLS) model is suitable.

- In linear regression models our aim is to estimate the parameters of the model but there is a possibility that the error terms are not independent which is one of the assumption of linear regression model, to overcome this problem we use a technique called **generalised least square** technique. It is a generalisation of the OLS model when homoscedasticity assumption of Gauss Markov Theorem is violated and hence OLS estimators derived are not BLUE (best linear unbiased estimator). In such a case, if all other assumptions of Gauss-Markov Theorem are satisfied, then GLS model can give BLUE estimators as this model relaxes the assumption that error terms are uncorrelated and homoscedastic.

3.6.6 Objective-wise Methodology

In order to calculate the percentage change directly, all the variables are converted to their natural logarithmic form throughout the analysis except for objective relating to study impact of production we have taken the variables in their original form not in their natural logarithmic form.

RO1: To study the energy intensity of energy intensive industries during pre and post policy intervention period

Panel Data modelling has been used to estimate Energy intensity of selected industries in India.

To get the most robust/appropriate results in all scenarios, following Regression Models are applied to both the datasets for all objectives namely,

- **Pooled Ordinary Least Square (OLS)**
- Pooled Ordinary Least Square (Robust)
- **Fixed Effect**
- Fixed Effect (Robust)
- **Random Effect**
- Random Effect (Robust)
- **Generalised Least Square (GLS)**
- Pooled Ordinary Least Square controlling for company specific effects
- Pooled Ordinary Least Square controlling for Industry specific effects
- Generalised Least Square controlling for company specific effects
- Generalised Least Square controlling for industry specific effects

Among these only the four most important regressions models are presented in the main text, rest are all presented in Annexure 4.1 and 4.2.

The econometric specification of the model is as follows:

To estimate Energy intensity, model is defined as a :

$$EI = f(PMI, A, LI, CI, RI, Si, TMI, PAT, ECA)$$

The specific equation form can be defined as:

$\ln EI_{it} = \alpha_1 + \alpha_2 \ln PMI_{it} + \alpha_3 \ln A_{it} + \alpha_4 \ln LI_{it} + \alpha_5 \ln CI_{it} + \alpha_6 \ln RI_{it} + \alpha_7 \ln SI_{it} + \alpha_8 \ln TMI_{it} + \beta_1 PAT + \beta_2 ECA + \varepsilon$

where, the notations have their meaning :

Model	Dependent Variable	Independent Variable
Model-1	Energy Intensity (EI)	Profit Margin Intensity (PMI) Capital intensity (CI) Labor intensity (LI) Firm size (Si) Age of the firm (A) Technology import intensity (TMI) Repairs Intensity (RI) $\begin{Bmatrix} PAT = 1\,; 2012 - 2015 \\ 0; elsewehere \end{Bmatrix}$ $\begin{Bmatrix} ECA = 1\,; 2001 - 2015 \\ 0; elsewehere \end{Bmatrix}$

The data set will be balanced data set indexed by i = 1,2,…..k, (k is the no. of companies) and t = 1, 2,.., 21

RO2 : <u>To analyze the role of energy cost and policy intervention on profitability and production of selected industries</u>

Panel Data modelling has been used to estimate Profitability and Production of selected industries in India.

To get the most robust/appropriate results in all scenarios, Eleven Regression Models are applied to both the datasets for all objectives namely,

- **Pooled Ordinary Least Square (OLS)**
- Pooled Ordinary Least Square (Robust)
- **Fixed Effect**
- Fixed Effect (Robust)
- **Random Effect**
- Random Effect (Robust)
- **Generalised Least Square (GLS)**
- Pooled Ordinary Least Square controlling for company specific effects
- Pooled Ordinary Least Square controlling for Industry specific effects
- Generalised Least Square controlling for company specific effects
- Generalised Least Square controlling for industry specific effects

Among these only the most important four regressions models are presented in the main text, rest are all presented in Annexure 5.1, 5.2 and 5.3.

The econometric specification of the model is as follows:

To estimate profitability/profit margin intensity, the model is defined as :

PMI = f(EI, A, LI, CI, Si, RI, TMI, PAT, ECA)

The specific equation form can be defined as:

ln PMI_{it} = α_1 + α_2 lnEI_{it} + α_3 ln A_{it} + α_4 ln LI_{it} + α_5 ln CI_{it} + α_6 ln SI_{it} + α_7 ln RI_{it} + α_8 ln TMI_{it} + β_1 PAT + β_2 ECA + ε

where, the variable are described in the following table :

Model	Dependent Variable	Independent Variable
Model-2	Profitability (PMI)	Energy intensity (EI) Labor intensity (LI) Firm size (S) Repairs intensity (RI) Age of the firm (A) Technology import intensity (TMI) $\begin{Bmatrix} PAT = 1\,; 2012 - 2015 \\ 0; elsewehere \end{Bmatrix}$ $\begin{Bmatrix} ECA = 1\,; 2001 - 2015 \\ 0; elsewehere \end{Bmatrix}$

data set will be balanced data set indexed by i = 1,2,…..k (where, k is no. of companies) and t = 1, 2,.., 21

<u>Model- 3</u>

The econometric specification of the model is as follows:

To estimate production, the model is defined as :

S = f (Energy, Profit, Age, Labor, Capital, Repairs, Techimp, PAT, ECA)

The specific equation form can be defined as:

$Sales_{it}$ = α_1 + α_2 $Energy_{it}$ + α_3 $Profit_{it}$ + α_4 Age_{it} + α_5 $Labor_{it}$ + α_6 $Capital_{it}$ + α_7 $Repairs_{it}$ + α_8 $Techimp_{it}$ + β_1 PAT + β_2 ECA + ε

where, the variable are described in the following table :

Model	Dependent Variable	Independent Variable
Model-3	Production (S)	Energy Expenses (Energy) Profit Labor expenses (Labor) Energy expenses (Energy) Age of the firm (Age) Repairs expenses (Repairs) Technology imports (Techimp) $\begin{Bmatrix} PAT = 1\,; 2012 - 2015 \\ 0; elsewehere \end{Bmatrix}$ $\begin{Bmatrix} ECA = 1\,; 2001 - 2015 \\ 0; elsewehere \end{Bmatrix}$

The data set will be balanced data set indexed by i = 1,2,…..no. of companies and t = 1, 2,.., 21

RO3 : <u>To study the emission intensity of selected industries during pre and post policy intervention period</u>

Panel Data model has been used to estimate Emission intensity of selected industries in India.

To get the most robust/appropriate results in all scenarios, Eleven Regression Models are applied to both the datasets for all objectives namely,

- **Pooled Ordinary Least Square (OLS)**
- Pooled Ordinary Least Square (Robust)
- **Fixed Effect**
- Fixed Effect (Robust)
- **Random Effect**
- Random Effect (Robust)
- **Generalised Least Square (GLS)**
- Pooled Ordinary Least Square controlling for company specific effects
- Pooled Ordinary Least Square controlling for Industry specific effects
- Generalised Least Square controlling for company specific effects
- Generalised Least Square controlling for industry specific effects

Among these only the most important four regressions models are presented in the main text, rest are all presented in Annexure 6.1.

<u>Model-4</u>

The econometric specification of the model is as follows:

To estimate emission intensity the model is defined as :

EMI = f(EI, PMI, A, LI, CI, RI, Si, TMI, PAT, ECA)

The specific equation form can be defined as:

$\ln EMI_{it} = \alpha_1 + \alpha_2 \ln EI_{it} + \alpha_3 \ln PMI_{it} + \alpha_4 \ln A_{it} + \alpha_5 \ln LI_{it} + \alpha_6 \ln CI_{it} + \alpha_7 \ln RI_{it} + \alpha_8 \ln SI_{it} + \alpha_9 \ln TMI_{it} + \beta_1 PAT + \beta_2 ECA + \varepsilon$

where, the meaning of notations are given as :

Model	Dependent Variable	Independent Variable
Model-3	Emission Intensity/Carbon-dioxide emissions* (EMI)	Capital intensity (CI) Labor intensity (LI) Energy intensity (EI) Firm size (S) Age of the firm (A) Repairs intensity (RI) Technology import intensity (TMI) $\begin{Bmatrix} PAT = 1\,; 2012-2015 \\ 0; elsewehere \end{Bmatrix}$ $\begin{Bmatrix} ECA = 1\,; 2001-2015 \\ 0; elsewehere \end{Bmatrix}$

*Carbon dioxide emissions at firm level is calculated using UK Government GHG Conversion Factors for Company Reporting, 2016, Department of Energy and Climate Change (DECC). The following formula is used :

$$Emissions\ on\ GHG = Activity\ Data\ \times Emission\ Conversion\ Factor$$

$$Total\ Emissions\ (K_g\ CO_2e) = Energy\ Consumption\ \times Emission\ Factor$$

The data set will be balanced data set indexed by i = 1,2,….k (where, k is no. of companies) and t = 1, 2,.., 21

3.6.7 Descriptive Data Analysis

The following tables provide the descriptive statistics for both the datasets as well as the graphs of variables by panel IDs.

Table 3.5: Descriptive Data Statistics for Dataset 1

Variable		Mean	Std. Dev.	Min	Max	Observations

Lnei	Overall	0.140441	0.1010587	0.0086805	0.529968	N =	546
	Between		0.0853984	0.0240128	0.4044472	n =	26
	Within		0.0564589	-0.0111107	0.5185395	T =	21
Lna	Overall	3.668526	0.519576	1.94591	4.634729	N =	546
	Between		0.4915123	2.760871	4.530472	n =	26
	Within		0.1929775	2.853565	4.203492	T =	21
Lnpmi	Overall	0.0523827	0.1300356	-0.8541315	0.8142117	N =	546
	Between		0.0813482	-0.1217622	0.3174091	n =	26
	Within		0.1026381	-0.6799865	0.6476276	T =	21
Lnli	Overall	0.0496608	0.0439557	0	0.2769525	N =	546
	Between		0.0292559	0.0073382	0.1255712	n =	26
	Within		0.0332806	-0.0759104	0.2010421	T =	21
Lnri	Overall	0.0141243	0.0120044	0	0.0748491	N =	546
	Between		0.0102744	0.0008755	0.0360013	n =	26
	Within		0.0065128	-0.0068265	0.0529722	T =	21
Lnsi	Overall	10.4237	1.534772	7.64177	15.667	N =	546
	Between		1.444785	8.103907	14.57866	n =	26
	Within		0.5871311	7.770078	12.51057	T =	21
Lnci	Overall	0.482385	0.2444889	0.0226326	2.917527	N =	546
	Between		0.139074	0.2071789	0.7499082	n =	26
	Within		0.2028374	-0.0464951	2.734806	T =	21
Lntmi	Overall	0.1384501	0.1537461	0	2.14851	N =	546
	Between		0.1008269	0.0201069	0.4399322	n =	26
	Within		0.1176643	-0.1611657	2.051277	T =	21
Lnemi	Overall	13.54307	1.819897	0.069854	18.58085	N =	546
	Between		1.381805	10.48979	16.34721	n =	26
	Within		1.213552	3.12314	17.6739	T =	21
Pat	Overall	0.1904762	0.3930368	0	1	N =	546
	Between		2.83E-17	0.1904762	0.1904762	n =	26
	Within		0.3930368	0	1	T =	21
Eca	Overall	0.7142857	0.4521682	0	1	N =	546
	Between		0	0.7142857	0.7142857	n =	26
	Within		0.4521682	0	1	T =	21

Source: Author's own calculation

Figure 3.1: Graph by Panel IDs for Dataset1

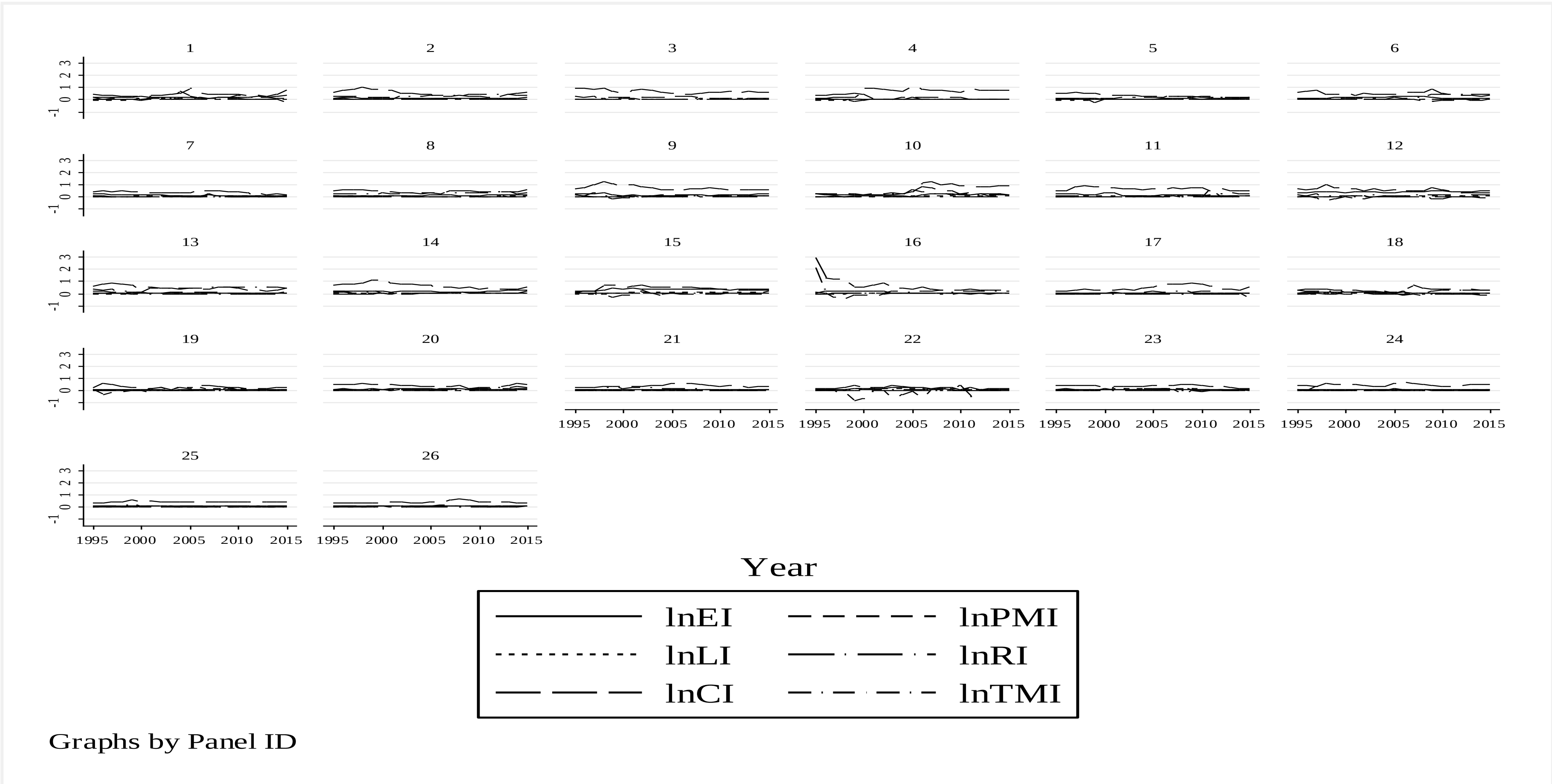


Table 3.6: Descriptive Data Statistics for Dataset 1 (Variables affecting Sales)

Variable		Mean	Std. Dev.	Min	Max	Observations
Sales	Overall	37198.52	167105.4	39.53695	1639440	N = 546
	between		131676.9	683.7738	678204	n = 26
	Within		105932.5	-590011.2	998434	T = 21
Profit	Overall	3089.109	12925.51	-14419.96	108356.8	N = 546
	between		11015.81	-131.5244	56353.73	n = 26
	Within		7083.351	-42413.93	55092.17	T = 21
Energy	Overall	1967.488	4395.015	2.493321	48782.32	N = 546
	between		3190.917	151.9095	13967.2	n = 26
	within		3083.481	-9890.341	36782.61	T = 21
Labor	overall	745.1787	1617.567	0	13858.08	N = 546
	between		1255.832	52.63669	5992.61	n = 26
	within		1047.513	-5247.432	8610.646	T = 21
Repairs	overall	206.1434	466.8945	0	4198.784	N = 546
	between		378.5692	4.987468	1769.112	n = 26
	within		282.7279	-1315.799	2635.815	T = 21
Capital	overall	19017.92	75165.33	75.77158	764922.6	N = 546
	between		63607.16	385.5708	327774.5	n = 26
	within		41862	-266511.2	456166	T = 21
Techimp	overall	20404.58	121972.2	0	1255274	N = 546
	between		91200.18	29.39713	466310.3	n = 26
	within		82855.19	-429855.7	809368.5	T = 21
Age	overall	43.38462	21.36366	6	102	N = 546
	between		20.90756	16	92	n = 26
	within		5.943156	33.38462	53.38462	T = 21
Pat	overall	0.1904762	0.3930368	0	1	N = 546
	between		2.83E-17	0.1904762	0.1904762	n = 26
	within		0.3930368	0	1	T = 21
Eca	overall	0.7142857	0.4521682	0	1	N = 546
	between		0	0.7142857	0.7142857	n = 26
	within		0.4521682	0	1	T = 21

Source: Author’s own calculation

Figure 3.2: Graph by Panel IDs for Dataset 1 (Sales)

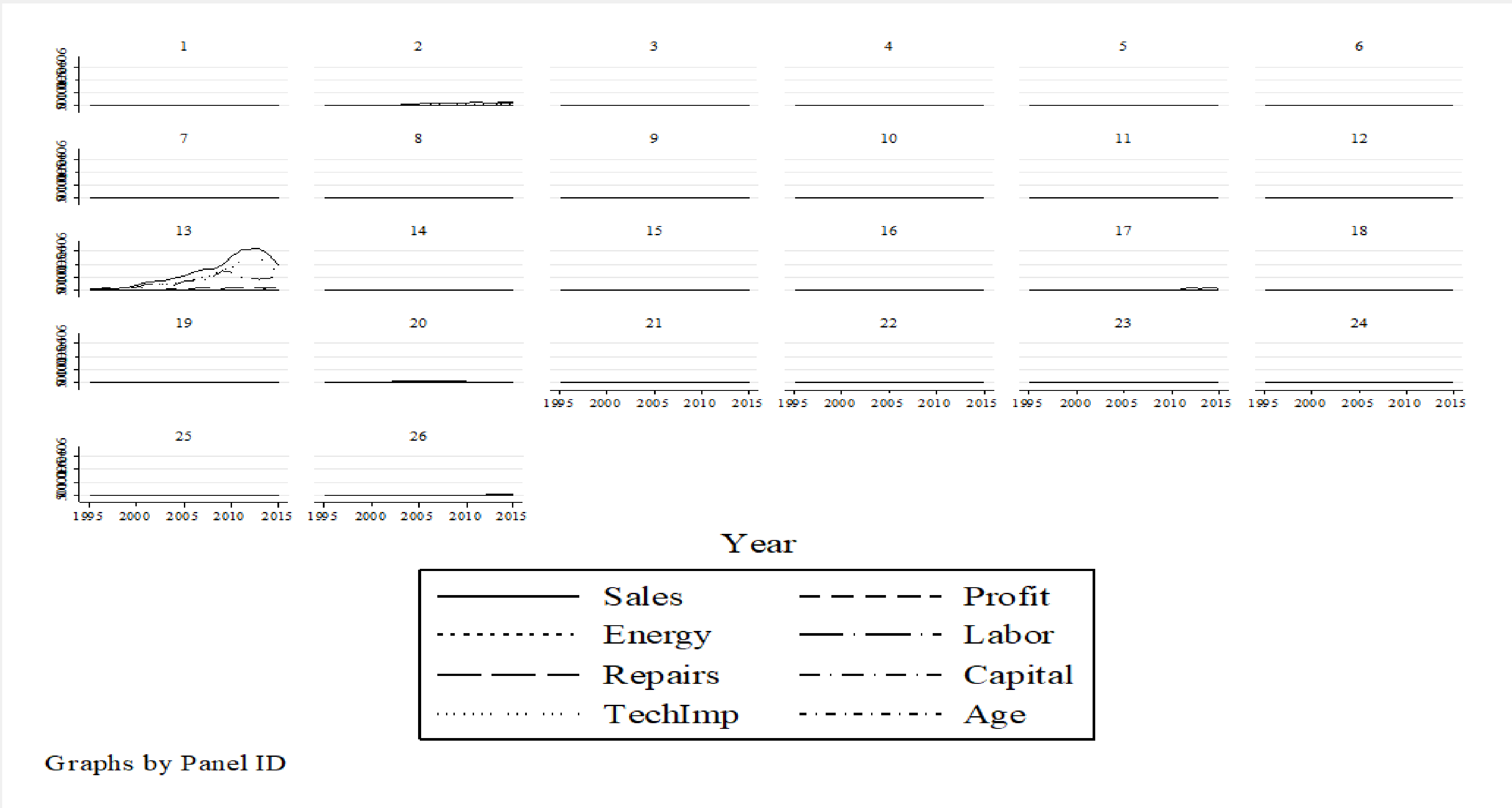


Table 3.7: Descriptive Data Statistics for Dataset 2

Variable		Mean	Std. Dev.	Min	Max	Observations
Lnei	Overall	0.109787	0.1026887	0	0.5135279	N = 1302
	Between		0.0935885	0	0.3173903	n = 62
	Within		0.0438269	-0.109595	0.4857864	T = 21
Lna	Overall	3.613402	0.5642794	0	4.691348	N = 1302
	Between		0.516357	2.160959	4.593243	n = 62
	Within		0.236401	1.452443	4.496965	T = 21
Lnpmi	Overall	0.032462	0.1756795	-1.919938	0.6580386	N = 1302
	Between		0.1008736	-0.405385	0.250343	n = 62
	Within		0.1443754	-1.735988	0.7320616	T = 21
Lnli	Overall	0.045713	0.0394438	0	0.3242846	N = 1302
	Between		0.0292519	0.0117766	0.1797263	n = 62
	Within		0.0267076	-0.134013	0.2854707	T = 21
Lnri	Overall	0.015356	0.0141651	-0.003044	0.1854778	N = 1302
	Between		0.0103083	0.0002463	0.0490764	n = 62
	Within		0.0097991	-0.015162	0.1661311	T = 21
Lnsi	Overall	10.51448	1.736643	0	15.0056	N = 1302
	Between		1.524128	6.682244	14.35933	n = 62
	Within		0.8536234	1.547813	14.0379	T = 21
Lnci	Overall	0.499488	0.3181465	0	2.250326	N = 1302
	Between		0.2485474	0	1.569732	n = 62
	Within		0.2009752	-0.173874	1.622198	T = 21
Lntmi	Overall	0.087791	0.1411084	0	2.249989	N = 1302
	Between		0.0964966	0	0.5383961	n = 62
	Within		0.1036491	-0.317631	1.799385	T = 21
Lnemi	Overall	21592.42	523158.4	4.834439	1.30E+07	N = 1176
	Between		161472.4	11.23063	1208363	n = 56
	Within		498061.5	-1186761	1.18E+07	T = 21
Pat	Overall	0.190476	0.3928276	0	1	N = 1302
	Between		0	0.1904762	0.1904762	n = 62
	Within		0.3928276	0	1	T = 21
Eca	Overall	0.714286	0.4519275	0	1	N = 1302
	Between		0	0.7142857	0.7142857	n = 62
	Within		0.4519275	0	1	T = 21

Source: Author's own calculation

Figure 3.2: Graph by Panel IDs for Dataset 2

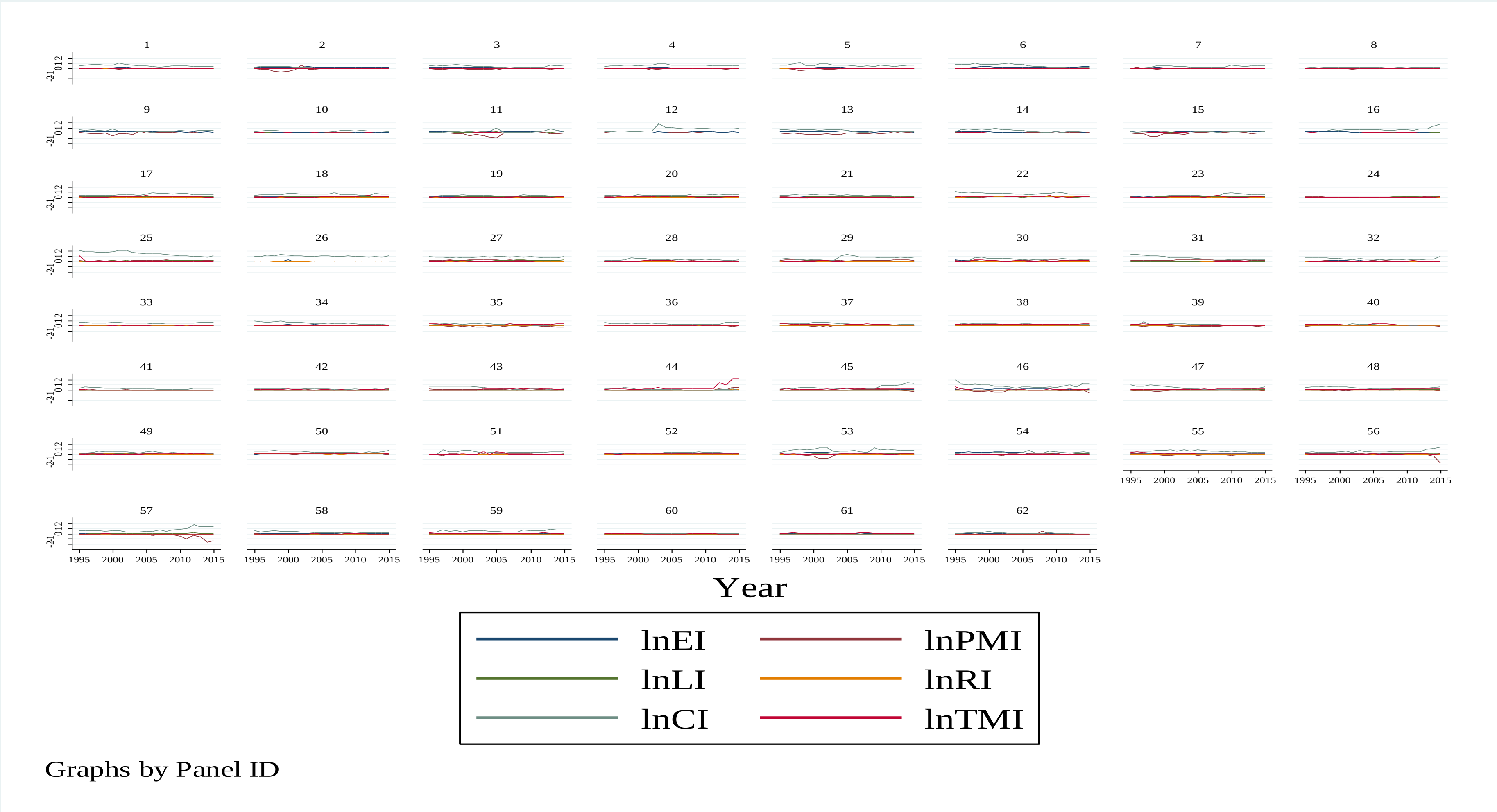
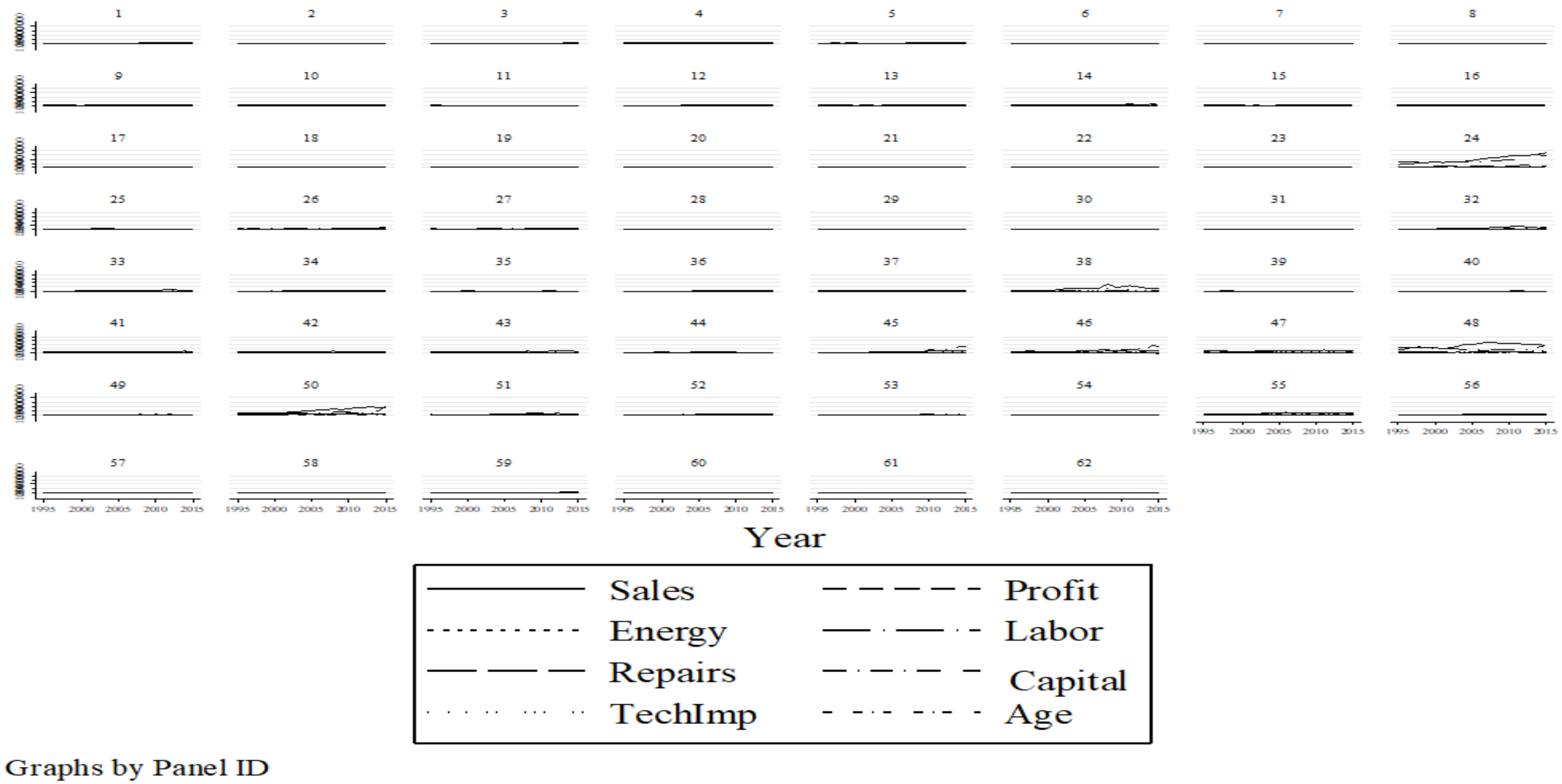


Table 3.8: Descriptive Data Statistics for Dataset 2 (Variables Affecting Sales)

Variable		Mean	Std. Dev.	Min	Max	Observations
Sales	overall	17727.69	37765.62	70.70077	288722.3	N = 1300
	between		34801.68	431.9283	184121.4	n = 62
	within		15227.58	-91759.9	130577.6	T-bar = 20.9677
Profit	overall	1527.153	6002.013	-22466.4	54337.71	N = 1302
	between		4960.791	-2777.67	33968.21	n = 62
	within		3434.099	-26606	32989.35	T = 21
Energy	overall	1237.289	2741.526	0	22305.52	N = 1302
	between		2454.988	3.06E-40	15368.28	n = 62
	within		1257.636	-7146.27	14258.09	T = 21
Labor	overall	1004.267	2931.056	0	33081.36	N = 1302
	between		2707.289	4.213458	18477.57	n = 62
	within		1172.326	-10013.6	15608.06	T = 21
Repairs	overall	361.4331	1236.453	-0.21487	14884.77	N = 1302
	between		1024.549	3.405949	5178.148	n = 62
	within		703.7411	-4132.87	10068.05	T = 21
Capital	overall	12695.09	30375.16	0	355476	N = 1302
	between		27341.03	0	179393.4	n = 62
	within		13660.53	-42385.6	188777.7	T = 21
Techimp	overall	2679.115	7426.796	0	80517.19	N = 1302
	between		6041.699	0	37486.9	n = 62
	within		4383.641	-22749	45709.4	T = 21
Age	overall	41.35484	20.00749	0	108	N = 1302
	between		19.21671	10	98	n = 62
	within		6.057627	31.35484	51.35484	T = 21
Pat	overall	0.190476	0.392828	0	1	N = 1302
	between		0	0.190476	0.190476	n = 62
	within		0.392828	0	1	T = 21
Eca	overall	0.714286	0.451928	0	1	N = 1302
	between		0	0.714286	0.714286	n = 62
	within		0.451928	0	1	T = 21

Source: Author's own calculation

Figure 3.4: Graph by Panel IDs for Dataset 2 (Sales)



3.6.8 Unit-root test

Test for stationarity of all the variables is important when dealing with panel dataset. Since we have taken panel data for our analysis, we have tested stationarity of the data firstly. For this, most acceptable test in literature, panel unit root test is applied for all the variables used in the study individually.

A number of tests exists to test the stationarity of the variables. We have selected the two out of these for our study namely, Levin–Lin–Chu (LLC) and Im-Pesaran-Shin (IPS). There is a problem of serial correlation with LLC test which cannot be completed removed, therefore it has low power when we have small sample to test but it accounts for heterogeneity in various sections. The null hypothesis of these unit root tests are there exist unit root implying that the variables are non-stationary, and the alternative hypothesis is that there is no unit root implying that the variables are stationary. Table 3.9 and 3.10 shows the results of each variable for panel unit root tests. It can be seen from Table 3.9 and 3.10, that at some or the other tests all variables are stationary at level means at I(0). It can also be seen from the results that almost all of the variables are stationary at level at 1 percent level of significance therefore we have considered all the variables at level for our analysis and not at first difference.

Table 3.9 : Unit-root test results (*Dataset 1)*

Variables	LLC (Levin-Lin-Chu) Test				(IPS) Im-Pesaran-Shin Test			
	Without Trend (Only Constant)		With Trend (Constant and Trend)		Without Trend (Only Constant)		With Trend (Constant and Trend)	
	Adjusted t* (At level)	First Difference (Adjusted t*)	Adjusted t* (At level)	First Difference (Adjusted t*)	W-t-bar (At level)	First Difference (W-t-bar)	W-t-bar (At level)	First Difference (W-t-bar)
lnA	-41.4705***	-29.1303***	-32.2958***	-29.1303***	-1.8e+02***	-62.6137***	-1.1e+02***	-50.5740***
lnPMI	-4.0057***	-11.9566***	-2.9542***	-9.5657***	-4.0605***	-12.8083***	-2.5238***	-9.5364***
lnEI	-5.6751***	-10.3395***	-2.4852***	-9.5188***	-3.2321***	-10.8596***	0.1530	-9.6151***
lnLI	-3.9352***	-8.1449***	-3.2199***	-6.1636***	-2.3812***	-9.5357***	-0.6108	-7.2640***
lnRI	-3.6196***	-12.2109***	-4.1349***	-9.9942***	-3.0034***	-11.9752***	-1.6412**	-9.3743***
lnSI	-4.0043***	-4.3330***	-5.4695***	-3.1609***	-0.7285	-3.4260***	-1.6325**	-0.7002
lnCI	-3.5630***	-6.9005***	-2.8171***	-5.0697***	-2.5976***	-8.0031***	-0.6547	-5.2601***
lnTMI	0.4220	-10.1707***	0.2337	-9.2974***	-2.8803***	-15.5727***	-2.6340***	-13.4961***
lnS	-3.4444***	-6.0764***	-0.3408	-5.5583***	0.2572	-7.2253***	2.0919	-5.2079***

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

Table 3.10 : Unit-root test results (*Dataset 2*)

Variables	LLC (Levin-Lin-Chu) Test				(IPS) Im-Pesaran-Shin Test			
	Without Trend (Only Constant)		With Trend (Constant and Trend)		Without Trend (Only Constant)		With Trend (Constant and Trend)	
	Adjusted t*	First Difference (Adjusted t*)	Adjusted t*	First Difference (Adjusted t*)	W-t-bar	First Difference (W-t-bar)	W-t-bar	First Difference (W-t-bar)
lnA	-65.7891***	-56.0136***	-48.8812***	-41.8938***	-2.8e+02***	-1.1e+02***	-1.9e+02***	-86.8068***
lnPMI	-1.5108*	-13.9821***	0.2216	-12.0481***	-3.6825***	-17.6178***	-0.3266	-13.8048***
lnEI	-18.6864***	-10.0069***	-8.2331***	-8.4027***	-4.5312***	-15.9300***	-2.6540***	-12.5461***
lnLI	-7.0467***	-16.7220***	-8.4313***	-13.9771***	-4.5312***	-15.9300***	-2.6540***	-12.5461***
lnRI	-5.1008***	-13.9119***	-6.5754***	-10.4014***	-3.1329***	-18.3147***	-3.0392***	-14.6378***
lnSI	-6.3675***	-62.7548***	-20.7404***	-54.2105***	-4.5011***	-21.7134***	-13.6716***	-16.7342***
lnCI	-2.3035***	-17.7108***	-3.0678***	-14.2698***	-0.1303	-14.3860***	0.1057	-10.5104***
lnTMI	-1.8355**	-7.7369***	0.2482	-4.4009***	-3.1329***	-18.3147***	-3.0392***	-14.6378***
lnS	-6.0501***	-14.1256***	-4.3480***	-12.2327***	-0.1303	-14.3860***	0.1057	-10.5104***

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

The above chapter talked about the detailed methodology used in the coming chapters. For details about the methodology used at any point in this thesis please refer this chapter. The following chapters are the detailed analysis chapters of the thesis and the last chapter talks about conclusion and recommendation.

CHAPTER 4

ESTIMATION OF ENERGY INTENSITY IN ENERGY-INTENSIVE INDUSTRIES IN INDIA

4.0 Introduction

Energy is the most important constituent that is necessary for all development in the economy. In fact the relation between the two is a prominent one, for a country to develop energy is required. Energy consumption in India has been steadily increasing. According to BP Energy Outlook 2017, in India consumption of energy grows at the rate of 4.2 percent a year which is faster than all major countries in the world and will overtake China. Among Asian Countries, India is the second largest energy consumer since 2008.

India holds the third position as fossil fuels consumer (primary energy) in the world (BP SRWE, 2016). The aggregate consumption of primary energy in India was around 100 mtoe (The ET, January 27, 2017). The industrial sector in India consumed about 30 percent (185 Mtoe) of the total final energy consumption of around 527 Mtoe in 2013. (India Energy Outlook, IEA, 2015).

The growth process in all sectors of the economy is driven by the industries which is the most prominent sector contributing to GDP of India. Industry sector contributes around 29.73 percent of our GDP (MoSPI, 2018-19). Being high in energy consumption, of the aggregate commercial energy consumption in India, industrial sector accounts for around 50 percent consumption. Among the industrial sector, the industries like thermal power plants, iron and steel, pulp and paper, textiles, cement, fertilizers, chlor alkali etc. consumes greater than 60 percent of the aggregate energy consumed by industries in India (BEE, 2011).

Government of India undertook many important initiatives to reduce energy intensity of all economic processes in the economy. One such important initiative is Energy Conservation Act (ECA) introduced in the year 2001. The Act proposed adherence energy norms for energy consumption for heavy consumers, developed new Energy Conservation Building Code for new buildings, standards for efficient energy performance and also started the practice of displaying labels indicating energy consumption on appliances.

Also, initiatives were undertaken to reduce energy intensity particularly targeting Indian industries called PAT. The first cycle of this mechanism ran from 2012-15. PAT is a mix of regulation in which the government has set mandatory energy intensity targets in combination of trading energy savings certificates by formation of a market and thereby increasing its cost efficiency.

As energy cost being an important variable affecting production cost of Indian industries therefore the objective of our study is to estimate energy intensity of energy-intensive sectors/industries covered under PAT Cycle-I. Also thereby studying the impact on energy intensity of these sectors due to implementation of Energy Conservation Act, 2001 and PAT in 2012 accounting for these variables in dummy variable form.

4.1 Literature Review

Kumar (2003) and Sahu and Narayan (2009) has conducted a study to find out the factors affecting energy intensity of manufacturing industries. They used multiple regression technique to carry out their analysis. Kumar used eight years data for 1342 firms for their analysis whereas 2350 firms data for the year 2008 for their analysis. In 2017, Oak published a paper on factors affecting energy intensity of firms in Indian cement industry and also quantifying the effect of Perform, Achieve and Trade effect using panel data fixed effect model and difference-in-difference technique. The source of data for all these studies is CMIE Prowess database. Most of the explanatory variables used in these studies are similar such as firm size, age of the firm, technology import intensity, ownership. According to the authors, ownership (foreign or domestic), firm size, age are the important determinants of energy intensity in Indian manufacturing industry. Oak (2017) found cement firms having higher energy intensity to be covered under PAT Cycle-I (2012-15) are correctly identified by Government of India though cement industry did not become energy efficient after the scheme was launched.

PAT- Perform Achieve and Trade was extensively studied by the Bhandari and Shrimali (2017). They used primary and secondary data sources including some government documents to gather the information and concluded that PAT targets are easy to achieve and therefore companies can achieve the target for reducing the energy intensity without making any extra investment in terms of energy efficiency practices. They also proposed that amendment needs to cater these issues to make PAT more effective.

Teng (2012) carried out a similar analysis taking into account indigenous Research and Development to study the effect on energy intensity of Chinese industries. Mukherjee (2008) accounted for inter-state heterogeneity and carried out the similar analysis for the period of 1998-2003 using Data Envelopment Analysis for Indian industries.

Our dataset for this study is a panel data. According to Jirata et al., 2015, panel data are becoming common due to innumerable advantages such as the ability to control for time invariant omitted variables which may lead to bias in observed relationships. Amri and Mouelhi (2014) studied impact of competition on Tunisian Manufacturing Firms used panel data econometrics using firm data over the period 1997-2002. Competition was found to have a strong positive effect on total factor productivity growth. Jiang (2013) used monthly panel data from 1983 to 2007 for 48 states for analyzing the factors that influences price of gasoline. Martins and Fernandes (2008) used household level data for the year 2001-02 to find out the factors affecting poverty in Cape Verde using econometric approach of multivariate regression analysis. The results showed the determinants of poverty to be the level of education, size of the household, engagement in agriculture, geographical location of rural or urban.

4.2 Methodology

To achieve the above objective following methodology is followed:

We have considered all the eight sectors included under PAT Mechanism, Cycle-I (2012-15) namely Aluminum, Cement, Chlor-Alkali, Fertilizers, Iron & Steel, Pulp & Paper, Textiles and Thermal Power Plants. Under PAT, plants of various companies have been included but since plant level data is not available, we have taken firm level data (company level data) for our analysis.

Based on their energy consumption to be called a Designated Consumer under PAT, these sectors are divided into two datasets based on PAT Booklet, Ministry of Power, Government of India, July, 2012. This also needs to be done to overcome the problem of availability of data only for few companies covered under PAT on CMIE Prowess. Under each sector certain companies for which data is available are included in the study and these companies are also covered under PAT Cycle-I. For details regarding companies included in the study please refer the detailed methodology in Chapter 3 of this thesis. The time period selected for the study is **1995-2015** because it will help us to study the impact of both Energy Conversation Act, 2001 (ECA) and Perform, Achieve and Trade (PAT) Cycle-I (2012-15) on energy intensity, profitability and emission intensity of industries.

The variables in this study are:

i) *Profits Margin intensity (Profitability)*: It is one of the important variable affecting energy intensity of industries as more profits imply more provision for investment in profit margin intensity. The variable has also being used for their analysis by Sahu and Narayan (2014), Cantore and Cali (2011). It is defined as Profit After Tax to Sales.

ii) *Capital Intensity*: The variable capital intensity is also a variable affecting energy intensity. It has been used previously by Sahu and Narayan (2009, 2011), Subrahmanya (2006), Dargay et. al (1983), Lachaal et. al (2005), Morikawa (2012), Kumar (2003), Oak (2017), Goldar (2010), Papadogonas et. al. (2007), A.Miketa (2001). in their analysis. More use of capital goods implies more use of energy for running those capital goods. This variable is defined as Net Fixed Assets as a proportion of Sales.

iii) *Labor intensity:* It is defined as wages and salaries divided by sales. More usage of labor in production process implies less use of energy. This variable has been used by Sahu and Narayan (2009, 2011), Subrahmanya (2006), Dargay et. al (1983), Lachaal et. al (2005), Morikawa (2012), Kumar (2003), Oak (2017), Goldar (2010), Papadogonas et. al. (2007), A.Miketa (2001) in their analysis.

iv) *Firm size:* It is defined as sum total of sales and total assets of a company in last three years. This variable can affect energy intensity of industries both directly and indirectly. This variable has been used by various authors namely

Sahu and Narayan (2009, 2011), Goldar (2010), Kumar (2003), Oak (2017), Papadogonas et. al. (2007), Oczkowski and Sharma (2005), Faruq and Yi (2010).

v) *Firm's age:* This variable is defined as current year minus age of incorporation of the company. This variable can also affect energy intensity both directly and indirectly. This variable has been used previously by many authors namely Sahu and Narayan (2009, 2011), Goldar (2010), Kumar (2003), Oak (2017), Papadogonas et. al. (2007), Oczkowski and Sharma (2005), Faruq and Yi (2010).

vi) *Technology import intensity:* Technology import intensity is an important variable affecting energy intensity of industries highlighted by many authors namely Sahu and Narayan (2009, 2011), Goldar (2010), Kumar (2003), Kumar (1987), Oak (2017). More technology imports imply less energy intensity of industries.

vii) *Repairs intensity:* It is defined as the expenditure on Repairs of Plant and Machinery divided by Sales. High repairs of plant and machinery implies more energy intensity.

viii) *PAT:* taking PAT-I (2012-2015) in dummy variable form

ix) *ECA:* implying Energy Conservation Act, 2001 is used in dummy variable form.

Due to unavailability of production data on CMIE Prowess we have taken "Sales" as a proxy for "Production" for our analysis. All the variables except Age are in Rs. Million (as extracted from CMIE Prowess). Therefore, in order to correct it for Inflation we have used Index of Industrial Production (IIP) data (from Indiastat.com and used the following formula to correct for Inflation :

(Current value of variable/IIP) x 100

All the variables are also converted into its natural logarithmic form in order to calculate percentage change directly and to ease the interpretation of results.

To estimate the energy intensity of Indian industries considered here panel data modeling has been used

To get the most robust/appropriate results in all scenarios, Four Regression Models are applied to both the datasets for all objectives namely,

- Pooled Ordinary Least Square (OLS)
- Fixed Effect
- Random Effect
- Generalised Least Square (GLS)

Each of the above regression models is different in its specification and is appropriate to apply to our panel data to get most robust results taking into account various scenarios.

In general, the model is specified as:

To estimate Energy intensity, model is defined as a :

EI = f(PMI, A, LI, CI, RI, Si, TMI, PAT, ECA)

where, the notations are defined as :

Model	Dependent Variable	Independent Variable
Model	Energy Intensity (EI)	Profit Margin Intensity (PMI) Capital intensity (CI) Labor intensity (LI) Firm size (Si) Firm's age (A) Technology import intensity (TMI) Repairs Intensity (RI) $\begin{Bmatrix} PAT = 1\,; 2012 - 2015 \\ 0; elsewehere \end{Bmatrix}$ $\begin{Bmatrix} ECA = 1\,; 2001 - 2015 \\ 0; elsewehere \end{Bmatrix}$

The data set will be balanced data set indexed by i = 1,2,…..k, (k is the no. of companies) and t = 1, 2,.., 21.

4.3 Estimation And Results

4.3.1 Unit-root test : Testing for stationarity of all the variables is important when dealing with panel dataset. Since we have taken panel data for our analysis we have to test stationarity of the data first and then proceed further. For this, unit root test is used. This step is necessary in order to get accurate results in the analysis. For detailed unit-root test results please refer Chapter 3, section 3.5.8

4.3.2 Regression Results

We have applied four models namely Pooled Ordinary Least Square (OLS), Fixed Effect, Random Effect, Generalised Least Square (GLS). Along with sensitivity analysis there are other seven models, each different in their specification were also used for analysis purpose in order to get the most accurate results. Results of these are presented in the Annexure 4.1 and 4.2. The results of the models presented in annexures are also same/similar to the ones presented here in the main body of this thesis.

<u>Dataset 1</u>

Table 4.1: Regression Results indicating impact on Energy intensity (Lnei) of industries for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**
	Pooled OLS (Lnei)	**Fixed Effect (Lnei)**	**Random Effect (Lnei)**	**Generalised Least Square (Lnei)**
Lnpmi	-.1383749*** (.0305187)	-.0963204*** (.0230025)	-.0968724*** (.022783)	-.1383749*** (.0302379)
Lna	-.0364682*** (.0087942)	.0226978 (.0238962)	.0044336 (.0185134)	-.0364682*** (.0087133)
Lnli	.5432704*** (.1013389)	.3098308*** (.0825247)	.3178417*** (.0816288)	.5432704*** (.1004066)
Lnci	.0677819*** (.0171141)	.0445515*** (.0128156)	.045651*** (.0127173)	.0677819*** (.0169566)
Lnri	.9670978*** (.3211815)	.2318607 (.37542)	.2825343 (.3612373)	.9670978*** (.3182267)
Lnsi	-.0170644*** (.0027179)	-.0115348** (.0054122)	-.0110379*** (.0045662)	-.0170644*** (.0026929)
Lntmi	-.0493375** (.0272692)	-.0747892*** (.0212312)	-.0757695*** (.0210543)	-.0493375** (.0270183)
_cons	.3985478*** (.0428066)	.1691403** (.0702514)	.2257297*** (.0635343)	.3985478*** (.0424128)
Pat	.0242275** (.0101263)	.008617 (.0072333)	.0119401* (.0069751)	.0242275** (.0100331)
Eca	-.0144478* (.0095504)	-.025375*** (.0080925)	-.0210056*** (.007522)	-.0144478* (.0094625)
Number of obs.	546	546	546	546
Number of groups	26	26	26	26
F	F(9, 536) = 22.91	F(9,511) = 9.44	Wald chi2(9) = 91.92	Wald chi2(9) = 210.05

Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

The statistics of table 4.1 shows the effect of all explanatory variables on the energy intensity (explained variable) taking both the dummy variables PAT and ECA simultaneously. It can be seen from table 4.1, the variable profit margin intensity (ln PMI) was found to be highly significant and has a negative relationship with energy intensity (EI). This could be interpreted as more profits earned by companies provide avenues for more investment in energy efficiency practices and hence reducing their energy consumption. According to pooled OLS model, when profit margin intensity rises by 1% energy intensity decreases by 0.138% whereas, fixed effect model and random effect model states for a decrease of 0.096% of energy intensity, 1% increase in profit margin intensity is required. Result of generalized least square model is same as pooled ordinary least square model.

A significant and inverse relation was found between age of the firms and their energy intensity implying with increase in age of the company its energy intensity will decrease, may be because as the company grew older it get more experienced in market and started investing in energy efficiency practices. According to Pooled OLS and GLS models (where it is found significant), a 1% increase in age of the company will reduce its energy intensity by 0.036%.

A significant and positive relation was found between labor intensity and energy intensity of firms. According to Pooled OLS Model, a 1% rise in labor intensity will raise energy intensity by 0.543%. According to Fixed Effect Model, a 1% rise in labor intensity will raise energy intensity by 0.309%. According to Random Effect Model, a 1% raise in labor intensity will raise energy intensity by 0.32%. According to GLS Model, a 1% rise in labor intensity will raise energy intensity by 0.543%.

A significant and inverse relation was found between capital intensity and energy intensity of firms implying as the usage of capital goods in the production process increases by firms their energy intensity will also increase. Similar kind of relation was found by Papadogonas et al. (2007) and Sahu and Narayan (2009) in case of Hellenic and Indian manufacturing sector respectively. According to Pooled OLS Model, a 1% rise in capital intensity will raise energy intensity by 0.06%. According to Fixed Effect Model, a 1% rise in capital intensity will raise energy intensity by 0.04%. According to Random Effect Model, a 1% rise in capital intensity will raise energy intensity by 0.05%. According to GLS Model, a 1% rise in capital intensity will raise energy intensity by 0.07%.

As per the result of regression analysis, repair intensity (independent variable) and energy intensity (dependent variable) shares a positive relationship that means if a company is spending more money on machinery repairs then that machineries are contributing more to energy intensity. A significant relationship for this variable has been found in some models only but the findings are similar to the results of Sahu and Narayan (2009) in their analysis of energy intensity of manufacturing industries in India. According to Pooled OLS and GLS models (where it is found significant), a 1% increase in repairs intensity of the company will increase its energy intensity by 0.967%.

On the basis of the result from all the models we have seen that the as the monetary value (size) of a company rises energy intensity decreases which is similar to the result of the study done by Kumar (2003) and negation of Sahu and Narayan (2009). The logic behind this inverse relation could be interpreted as “if the industry produces as large scale its per unit usage of resources decline as compared to when it produces at the small scale”. According to pooled OLS model result 1% rise in size will lead to 0.017% decline in energy intensity.

According to Fixed Effect Model, when size rises by 1%, energy intensity will decline by 0.011%. According to Random Effect Model, when size rises by 1%, energy intensity will decline by 0.011%. According to GLS Model, when profits margin intensity rises by 1%, energy intensity will decline by 0.023%.

In some of the models, technological import intensity is significant and share the negative relation with energy intensity. This may be interpreted as the companies will invest more on import from outside India for advancement of technology it will use less energy and therefore energy intensity of firm reduces. According to Pooled OLS Model, when technology import intensity rises by 1%, energy intensity will decline by 0.049%. According to Fixed Effect Model, when technology import intensity rises by 1%, energy intensity will decline by 0.075%. According to Random Effect Model, when technology import intensity rises by 1%, energy intensity will decline by 0.075%. According to GLS Model, when technology import intensity rises by 1%, energy intensity will decline by 0.049%

The dummy variable representing PAT year has not been found significant in very few models and is seemed to be inversely related with energy intensity implying years in which PAT is present energy intensity of companies have increased.

But for ECA dummy, the coefficient is found to be significant in most of the models and have seemed to reduce energy intensity in ECA years of companies implying ECA to have the desired impact on energy intensity of companies. According to Pooled OLS Model, when there is ECA year, energy intensity will decline by 0.014%. According to Fixed Effect Model, when there is ECA year, energy intensity will decline by 0.025%. According to Random Effect Model, when there is ECA year, energy intensity will decline by 0.021%. According to GLS Model, when there is ECA year, energy intensity will decline by 0.014%.

Since according to all the models, $prob > F \; or \; prob > \chi 2$ value is less than 0.05 therefore all the models are considered to be statistically correct.

Table 4.2: Hausman Test Results for Dataset 1

	Coefficients			
	(b) fixed	(B) Random	(b–B) Difference	sqrt(diag(V_b-V_B)) S.E.
Lna	.0226978	.0044336	.0182642	.015109

Lnpmi	-.0963204	-.0968724	.000552	.00317
Lnli	.3098308	.3178417	-.0080109	.0121269
Lnri	.2318607	.2825343	-.0506736	.1022145
Lnsi	-.0115348	-.0110379	-.0004969	.0029056
Lntmi	-.0747892	-.0757695	.0009804	.0027354
Lnci	.0445515	.045651	-.0010995	.0015849
Pat	.008617	.0119401	-.0033231	.0019151
Eca	-.025375	-.0210056	-.0043694	.0029847

Source: Author's own calculation

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 9.00

Prob>chi2 = 0.4377

(V_b-V_B is not positive definite)

As per the Hausman test results, the null hypothesis is not rejected, hence random effect model seems to be most appropriate in this case but in order to get the most robust and appropriate results for our analysis we have applied all the models discussed above.

In order to decide between the pooled OLS and random effect model we have conducted Breusch and Pagan Lagrangian multiplier test (LM Test), the results of which are as follows:

Table 4.3: Breusch and Pagan Lagrangian multiplier test for Dataset 1

lnei[panelid,t] = Xb + u[panelid] + e[panelid,t]

Estimated results :

	Var	sd = sqrt(Var)
Lnei	.0102129	.1010587
E	.002915	.0539905
U	.0054319	.0737014

Source: Author's own calculation

Test: Var(u) = 0

chibar2(01) = 1836.53

Prob > chibar2 = 0.0000

As per the LM Test above, since the null hypothesis is rejected, Random Effect is most appropriate in this case. But in order to get most robust and appropriate results we have applied all the models discussed above.

<u>Dataset 2</u>

Table 4.4: Regression results indicating impact on Energy intensity of industries (Lnei) for Dataset 2

	Model-I	**Model-III**	**Model-V**	**Model-VII**
	Pooled OLS (Lnei)	**Fixed Effect Lnei)**	**Random Effect (Lnei)**	**Generalised Least Square (Lnei)**
Lnpmi	-.1386431*** (.0147093)	-.043904*** (.0092354)	-.0463722*** (.0092457)	-.1386431*** (.0146527)
Lna	.0310971*** (.0052154)	-.0034071 (.0092298)	.0044275 (.0083343)	.0310971*** (.0051953)
Lnli	-.2934836*** (.0721372)	-.0181267 (.0508057)	-.031264 (.0507085)	-.2934836*** (.0718597)
Lnci	.0314999*** (.0092266)	.0007538 (.0066538)	.0020494 (.0066289)	.0314999*** (.0091911)
Lnri	.3862165** (.1939222)	.4802578*** (.1393632)	.472917*** (.1392424)	.3862165** (.1931761)
Lnsi	-.0170617*** (.0016283)	-.003875** (.0018629)	-.0057945*** (.0017657)	-.0170617*** (.0016221)
Lntmi	-.1582078*** (.0193073)	-.0393351*** (.0129987)	-.0433391*** (.0130072)	-.1582078*** (.019233)
_cons	.1896644*** (.0215335)	.1681664*** (.0264521)	.1613248*** (.0266328)	.1896644*** (.0214506)

Pat	-.0078574 (.0067539)	-.0079381** (.0035868)	-.0086057** (.0035683)	-.0078574 (.0067279)
Eca	-.0016942 (.0061491)	-.0081985** (.0037514)	-.0091237** (.0036655)	-.0016942 (.0061255)
Number of obs.	1302	1302	1302	1302
Number of groups	62	62	62	62
F	F(9, 1292) = 46.91	F(9,1231) = 10.45	Wald chi2(9) = 103.85	Wald chi2(9) = 425.50
Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0001

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

Table 4.4 shows the impact of all the explanatory variables on energy intensity (explained variables) taking both the dummy variables pat and eca together.

Results of table 4.4 shows that profit margin intensity (lnPMI) is a significant variable in almost all the models used above. It shows that as the profit margin intensity increases the energy intensity decreases; i.e., there is a negative relation between them. This could be explained in the sense that industry could invest more in energy efficient technology if the profit of the company increases and hence reducing its energy consumption. According to Pooled OLS Model, when profits margin intensity rises by 1%, energy intensity will decline by 0.138%. According to Fixed Effect Model, when profits margin intensity rises by 1%, energy intensity will decline by 0.044%. According to Random Effect Model, when profits margin intensity rises by 1%, energy intensity will decline by 0.046%. According to GLS Model, when profits margin intensity rises by 1%, energy intensity will decline by 0.138%.

A significant and direct relation between the variable firm's age and energy intensity was found implying with increase in age of the company its energy intensity will also increase, may be because as the company grew older, the machinery and equipments used in production process gets outdated/old and hence using more energy. According to Pooled OLS and GLS models (where it is found significant), a 1% increase in age of the company will increase its energy intensity by 0.031%.

A significant and inverse relation was found between the variable labor intensity and energy intensity but only in few models. According to Pooled OLS and GLS Model (where it is found significant), a 1% rise in labor intensity will reduce energy intensity by 0.293%.

A significant and direct relation was found between capital intensity and energy intensity of firms but only in few models. According to Pooled OLS and GLS Model (where it is found significant), a 1% rise in capital intensity will increase energy intensity by 0.031%.

Result of all the models shows that repair intensity is directly affecting energy intensity that is if you spend more on repairs means machineries are neither efficient nor in a good condition and therefore consuming more energy. The coefficient of this variable is statistically significant for most of the models. The result is also supported by the study of Sahu and Narayan (2009).

According to the result of pooled OLS model for an increase of 0.386 % in energy intensity 1 % increase is required in repair intensity. According to fixed effect model for an increase of 0.48 % in energy intensity 1 % increase required in repair intensity. According to random effect model for an increase of 0.437% in energy intensity 1% increase is required in repair intensity and according to GLS model 1 % increase in repair intensity results in 0.386 % increase in energy intensity.

This discussion leads to the conclusion that if the monetary value (size) of firm increases it will contribute to decline in energy consumption per unit of output as proved by all the models as well as a study by Kumar (2003). However the findings by Sahu and Narayan (2009) does not support this result, they say there is an inverse relation between size of the company and energy intensity because if there is growth of the company definitely it will invest money in efficient and improved technology which leads to less energy consumption and hence energy intensity declines.

According to the result of pooled OLS model, when independent variable size contribute 1 % more the energy intensity reduces by 0.017 % the same result in terms of increase and decrease of variables is shown by generalized least square model whereas under the fixed effect model and random effect model when size rises by 1 % energy intensity will decline by 0.003 % and 0.006% respectively.

A significant and inverse relation was found between technology import intensity and energy intensity of firms. This may be interpreted as the companies will invest more on imports from outside India for advancement of technology it will use less energy and therefore energy intensity of firm reduces.

According to the result of pooled OLS model, when independent variable technology import intensity contribute 1 % more the energy intensity reduces by 0.158% the same result in terms of increase and decrease of variables is shown by generalized least square model whereas under the fixed effect model and random effect model when technology import intensity rises by 1 % energy intensity will decline by 0.039 % and 0.0.43% respectively.

It has been observed that PAT and ECA are seemed to be negatively related with energy intensity and found to be significant in some models. In other words, energy intensity of companies have decreased in the years in which PAT and ECA policies are present.

Table 4.5: Hausman Test Results for Dataset 2

	Coefficients			
	(b) fixed	(B) Random	(b–B) Difference	sqrt(diag(V_b-V_B)) S.E.
Lna	-.0034071	.0044275	-.0078346	.0039659
Lnpmi	-.043904	-.0463722	.0024682	.
Lnli	-.0181267	-.031264	.0131373	.0031411
Lnri	.4802578	.472917	.0073408	.005802
Lnsi	-.003875	-.0057945	.0019195	.0005937
Lntmi	-.0393351	-.0433391	.0040041	.
Lnci	.0007538	.0020494	-.0012956	.0005751

Pat	-.0079381	-.0086057	.0006676	.0003639
Eca	-.0081985	-.0091237	.0009252	.000798

Source: Author's own calculation

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 34.56

Prob>chi2 = 0.0001

(V_b-V_B is not positive definite)

As per the Hausman test results, the null hypothesis is rejected, hence fixed effect model seems to be most appropriate in this case but in order to get the most robust and appropriate results for our analysis we have applied all the models discussed above.

4.4 Conclusion And Recommendation

The results of our study are summarized as follows:

Table 4.6: Results Consolidation representing impact on Energy intensity of industries

Variables	***Dataset 1 (Aluminium/Chlor-Alkali/Textiles)***	***Dataset 2 (Cement/Iron and Steel/Fertilizer/Pulp and Paper/Thermal Power Plants)***
	Energy Intensity (lnei)	***Energy Intensity (lnei)***
Profit Margin Intensity (lnpmi)	Negative/Significant	Negative/Significant
Age (lna)	Negative/Significant	Positive/Significant
Labor Intensity (lnli)	Positive/Significant	Negative/Significant few models
Capital Intensity (lnci)	Positive/Significant	Positive/Significant few models
Repairs Intensity (lnri)	Positive/Significant	Positive/Significant
Size (lnsi)	Negative/Significant	Negative/Significant
Technology Import Intensity (lntmi)	Negative/Significant	Negative/Significant
Constant term	Positive/Significant	Positive/Significant
PAT	Positive/Significant few models	Negative/Significant
ECA	Negative/Significant	Negative/Significant

Source: Author's own work

As can be seen from table 4.6, an important and significant variable affecting energy intensity of energy-intensive industries is profits margin intensity in both the datasets. As this is the basis of our study this result is of utmost importance. Energy cost forms a major proportion of total production cost in these energy-intensive industries. The same is also very much highlighted by our results. A significant and inverse relation was found between energy intensity (energy cost) and profit margin intensity (profits) implying as the company earns more profits its energy intensity/cost will decline as investment in energy efficiency practices would be likely to be more profitable firms.
For the variable capital intensity, we found a positive and significant relationship implying firms using more machinery and capital equipments in their production process will be consuming more energy because machinery consumes more power and fuel to run increasing their energy consumption.
For the variable repairs intensity, a significant and direct relationship was found with energy intensity for both the datasets implying a firm indulging more in repairs of plant and machinery will also be consuming more energy.
A significant and inverse relationship was found between size of the firm and their energy intensity implying a firm which is bigger in terms of sales and assets will also invest more in energy efficient technologies and hence energy efficient consuming lesser energy.
A significant and inverse relationship was found between technology import intensity and energy intensive of firms implying firms importing technical know-how, equipments from abroad will be less energy intensive.
PAT doesn't seem to have affected the overall performance of industries much, in some models the relationship with energy intensity in negative sense was found to be significant like in dataset 2 and also in that case technology imports have affected/reduced the energy intensity. So this might be the reason behind decline in energy or bigger size of the firm or more profits be the reason. Whereas in case of ECA, it is found to be favorably affecting energy intensity, reducing it. As per government records also, Energy Conservation Act (ECA), 2001 reduced energy consumption of the economy by around 12 mtoe or 18000 million kWh reducing equivalent electricity generation by approx. 4GW or equivalent investment by approx.

20000 crore rupees between 2007 and 2010. The act was amended and strengthened in 2010 (Tata Strategic, 2014). This is in consent with our results too.

As per Bureau of Energy Efficiency, PAT Cycle-I (2012-15) led to an energy savings of 8.67 million toe against the target of 6.68 million toe. Also, 32 million tonnes of CO2 emissions have been reduced. But this is not in consent with our findings. It is also too early to judge its effectiveness as only its first cycle, 2012-15 has ended, not a very old policy measure in India.

According to The Hindu, BusinessLine article dated May 2, 2018, at the end of Cycle 1, there were some anomalies such as changes in power mix, fuel mix, market demand and unforeseen shutdown in the data were found during the monitoring and verification stage which has also led to oversupply of ESCerts (energy trading certificates connected to PAT) in market and therefore, PAT Cycle-I targets were easily achievable leading to energy savings more than the target set. The same has also been highlighted through a study conducted by Bhandari and Shrimali (2017), that the PAT Cycle-I targets were not that strict to cause reduction in energy intensity of industries beyond the usual scenarios and therefore not lead to any long-term investment.

Also, absence of any floor price for ESCerts worsen the situation as certificates were sold at as low as Rs. 200 to Rs. 1200 per certificate where it was supposed to sold at a price of atleast Rs. 10,000 per certificate. Due to this, defaulter designated consumers easily fulfilled their targets by purchasing low priced ESCerts and it seemed that it is a better and cheaper option to fulfill targets by purchasing ESCerts rather than investing in expensive energy efficient technologies (Rs. 100 crores against Rs. 24517 crores of investment) as per The Hindu BusinessLine article.

Hence, a lot of amendments needs to be done in PAT further cycles at both policy formation and implementation level, also stricter norms need to be set to bring about real change in industrial energy intensity and for it to be called an effective policy measure in India.

CHAPTER 5

IMPACT OF ENERGY COST AND POLICY INTERVENTION ON PROFITABILITY AND PRODUCTION OF INDUSTRIES

5.0 Introduction

As highlighted by many authors and reports, Energy intensity by Indian industries is high. There are few prominent types of Industries which are highly energy-intensive such as Cement, Pulp and Paper, Aluminium, Fertilizer, Iron and Steel etc. and termed as Designated Consumers (DCs) under EC Act, 2001. These industries have highest energy intensity among all manufacturing industries in India. Also, energy intensity varies over time as well as over type of economic activity (Ray, 2011; IEA, 2009). Energy cost forms a huge proportion of total production cost in Indian industries.

Energy cost in some of the sectors such as Fertilizer and Chlor Alkali is as high as 60 percent of their total production cost. In Cement, Aluminium and Iron & Steel sector energy cost ranges between 30-40 percent (AEEE, Shakti Foundation December 2011, PAT Booklet, Ministry of Power July 2012 , ASSOCHAM, 2006).

Since energy cost forms a huge proportion of total production cost in Indian industries, it is also very obvious and highlighted by many reports and articles that investing in energy efficiency measures and reducing energy intensity will also be helpful in increasing industry profits and thereby competitiveness.

This relation between reducing energy intensity and increasing profits is also highlighted by many reports and authors. According to World Steel Association, more energy efficiency implies production cost reduction and improvement in competitive position. As per UNIDO 2011, it has been emphasized in the energy economics literature that energy efficiency may provide both monetary and non-monetary benefits and it has also be confirmed by many studies that energy efficiency may increase firms' profitability.

Industrial Development Report, 2011 highlighted that one of the easiest ways to tackle climate change, make the air we breathe clean, improve business competitiveness and reduce energy costs is energy efficiency. As per ASSOCHAM report 2009, high energy costs is killing the competitiveness of Indian industries such as aluminium. The share of energy component has reached around 40 percent with regard to the manufacturing sector. Thus cost of energy is a significant component of industrial performance of India.

According to Australian Government, Department of Industry 2014 report, particularly in metals industry their energy cost is equal or sometimes even greater than companies' EBITDA which is a standard measure of profitability in accountancy. A 5 percent increase in these companies' EBITDA is possible by implementing energy efficiency practices. Practising energy efficiency in highly impacted companies will help reduce energy costs by about half an average.

Therefore, competitiveness of the companies' are also affected in terms of their reduced profitability with energy cost forming high proportion of their production cost.

Government of India undertook many important initiatives to reduce energy intensity of all economic processes in the economy. One such important initiative is Energy Conservation Act (ECA) introduced in the year 2001. The Act proposed adherence energy norms for energy consumption for heavy consumers, developed new Energy Conservation Building Code for new buildings, standards for efficient energy performance and also started the practice of displaying labels indicating energy consumption on appliances. Under this Act, Bureau of Energy Efficiency (BEE) was formulated to implement provisions defined by the Act.

Also, initiatives were undertaken to reduce energy intensity particularly targeting Indian industries called PAT. The first cycle of this mechanism ran from 2012-15. PAT is a mix of regulation in which the government has set mandatory energy intensity targets in combination of trading energy savings certificates by formation of a market and thereby increasing its cost efficiency.

From the literature review we could not find any study in context of India which talks about the impact of policy intervention particularly ECA, 2001 and PAT Cycle-I on profitability and production of energy intensive industries. Our main objective is to study the impact of these policy interventions on the performance of energy-intensive industries, therefore in this objective we are also studying whether the implementation of these policy interventions is affecting production or not. Energy-intensive industries consume around 60 percent of total industrial energy consumption in India therefore, it is very important to study whether these policy initiatives are seriously impacting industries or the results are just on paper not in reality. Also, being energy-intensive industries, as already stated these are very high on energy consumption so becoming energy efficient or reducing energy intensity might also affect production adversely which we will also check in this objective.

5.1 Literature review

There are few studies which are explaining relationship between energy intensity and profitability of industries and most of these are accounting terminology based which are not very much related to our study. Also, there are few studies related to impact on production. But none of these studies states the impact of policy intervention on profitability and production of energy-intensive industries.

Sahu and Narayan (2014) and Cantore and Cali (2011) studied the factors affecting of energy intensity of manufacturing industries. Sahu and Narayan (2014) studied this for Indian manufacturing industries and Cantore and Cali (2011) carried out the same in context of developing countries.

Sahu and Narayan (2014) found energy intensity to be directly affecting profitability of industries. In this context, Cantore and Cali (2011) found for manufacturing industries in most of the developing countries, more energy efficient the industry more profitable it is. The variables affecting profitability identified in both the studies are labor intensity, capital intensity, MNE affiliation/foreign-owned firms along with energy intensity. Labor intensity is found to be positively related with profitability as more labor implies less of capital means less energy consumption and hence more profits. Sahu and Narayan (2014) found firms using natural gas as main energy source to be more capital-intensive in comparison to firms using coal and oil. Cantore and Cali (2011) found foreign-ownership not a factor affecting profitability of manufacturing industries in developing countries whereas Sahu and Narayan (2014) found profitability of MNE affiliated firms using coal as main energy source is high in comparison to firms using petroleum and natural gas as main energy source.

Firm size, Research and development intensity, age of the firm, choice of fuel are found to be determinants affecting profitability whereas Cantore and Cali (2011) found exporting firm dummy, number of workers, raw material costs, Industry dummy, ISO9000 certification dummy to be other determinants affecting profitability.

For production of energy-intensive industries, generally the analysis is carried out in terms of change in total factor productivity, though it is not very much related to our study, this is the only literature we could find in this regard. Roy et al. (1999) studied the impact on total factor productivity of energy-intensive sectors of India using translog production function with growth accounting and econometric framework. The results suggest that being an ideal response to estimation to own price responses therefore increase in prices of energy is a good means of carbon abatement policy for India, inter-subsitution policies are relatively weak so increase in energy prices might have negative effect long term effect on productivity of these industries.

Schumacher and Sathaye (1999) studied the trend in productivity and energy efficiency in Indian Fertilizer industry during the period 1973-74 to 1993-94. Both growth accounting and econometric estimates were derived for this industry and translog specification was used. The results suggest that government policies such as retention price system and distribution control and fiscal incentives such as subsidies have a huge impact on productivity of Indian Fertilizer sector. There is substantial energy saving and carbon reduction potential in the industry and energy policies can overcome barriers to adoption of energy efficiency policies in this sector.

Sahu and Narayan (2011) studied the relation between energy intensity of manufacturing industries and their total factor productivity. They estimated transcendental logarithmic production function using four inputs capital, labor, materials and energy. The results suggests that labor and materials input play major role in affecting total factor productivity in comparison to capital and energy input. Energy intensity was indirectly related to total factor productivity of Indian manufacturing industries implying energy efficiency increases total factor productivity.

Worell et al. (2001) studied evaluated industrial energy efficiency measures in iron and steel industry in U.S. The findings suggest that investment in energy efficiency measures increases overall productivity in the industry so including a parameter for productivity benefits in model will double the cost-effectiveness of energy efficiency measures in industry.

Satpathy et al. (2017) used fully modified ordinary least squares (FMOLS) method measured total factor productivity of Indian manufacturing firms from 1998-99 to 2012-13 using Levinsohn–Petrin (L-P) method and also identified the factors affecting total factor productivity using fully modified ordinary least squares (FMOLS) method. The results suggest that technology is the main determinant affecting productivity along with size of the firm, intensity of raw material imports.

Haider and Ganaie tried to find out the dynamic linkage between energy efficiency and total factor productivity for the period of 1971-2013. The results indicate a unidirectional causality from energy efficiency to total factor productivity implying energy efficiency negatively impacting total factor productivity in India. Whenever energy intensity increases, total factor productivity also increases. Finman and Laitner reviewed various published industrial case studies across the world to study non-energy benefits of energy efficiency in terms of productivity improvement.

All these studies relates to impact/change in total factor productivity and none of them relates to impact on direct production of industries, our study tries to study impact of policy intervention PAT and ECA on overall performance of industries also in terms of profitability and production of industries.

5.2 Methodology

To achieve the above objective following methodology is followed:

We have taken the data for Textiles sector, Thermal power plant sector, Iron & steel sector, Aluminum sector, Pulp & paper sector, Fertilizer sector, Cement and Chlor-Alkali sector that is all the eight sectors covered under PAT mechanism for Cycle-I : 2012-2015.

Under PAT, plants of various companies have been included but since plant level data is not available, we have taken firm level data (company level data) for our analysis.

Based on their energy consumption to be called a Designated Consumer under PAT, these sectors are divided into two datasets based on PAT Booklet. This also needs to be done to overcome the problem of availability of data only for few companies covered under PAT on CMIE Prowess. Under each sector certain companies for which data is available are included in the study and these companies are also covered under PAT Cycle-I. For details regarding companies included in the study you can refer the detailed methodology in Chapter 3 of this thesis.

We have taken the data of 20 years, 1995-2015 for present study because this time period include the Energy Conversation Act (2001) and PAT-I (2012-2015) which is appropriate to understand the impact of these two policies on energy intensity, emission intensity, production and profitability of industries.

The variables affecting **Profitability of firms** included in this study are:

i) *Energy intensity:* It is the most important variable affecting profitability of industries. For our analysis we have taken the most energy-intensive industries in the country therefore, energy cost will obviously forms a huge proportion of total production cost in these industries and hence decline in energy cost will increase their profitability. The variable has also being used for their analysis by Cantore and Cali (2011), Sahu and Narayan (2014). It is defined as the ratio of power and fuel expenses to sales.

ii) *Capital intensity:* It is also a variable affecting profitability of industries. The variable has been used by some authors before such as Cantore and Cali (2011) and Sahu and Narayan (2014). It is defined as Net Fixed Assets as a proportion of Sales.

iii) *Labor intensity:* Labor intensity (manpower cost) is also a variable which can be connected to profitability of industries. This variable has also been used by Cantore and Cali (2011). Labor intensity is positively related to profitability. It is defined as ratio of salaries and wages to sales.

iv) *Firm Size:* Another variable affecting profitability is size of the firm. This variable has been used by Sahu and Narayan (2014), Al-Jafari and Samman (2015), Alahyari (2014), Sivathaasan et al. (2013), Mistry (2012), Bhayani

(2010) before for their analysis. It is defined as It is defined as sum total of sales and total assets of a company in last three years.

v) *Age of the firm:* It is also one of the variable profitability. It is defined as This variable is defined as current year minus age of incorporation of the company. It has been highlighted in their analysis by Sahu and Narayan (2014), Al-Jafari and Samman (2015), Alahyari (2014), Sivathaasan et al. (2013), Mistry (2012), Bhayani (2010).

vi) *Technology import intensity:* It is also an important variable affecting profitability of industries. More technology imports imply better technology less energy cost and hence huge profits. *Repairs intensity:* This variable is defined as the ratio of Repairs on Plant and Machinery Expenditure to Sales. High repairs of plant and machinery implies more energy intensity hence less profits.

vii) *PAT:* taking PAT-I (2012-2015) in dummy variable form

viii) *ECA:* implying Energy Conservation Act, 2001 is used in dummy variable form.

Due to unavailability of production data on CMIE Prowess we have taken “Sales” as a proxy for “Production” for our analysis. All the variables except Age are in Rs. Million (as extracted from CMIE Prowess). Therefore, in order to correct it for Inflation we have used Index of Industrial Production (IIP) data (from Indiastat.com and used the following formula to correct for Inflation :

(Current value of variable/IIP) x 100

All the variables are also converted into its natural logarithmic form in order to calculate percentage change directly and to ease the interpretation of results.

The following are the variables affecting **Production of firms:**

i) *Energy Expenses*: It is one of the variables affecting production of firms. If there are more expenses incurred on energy then there should be more production. It is defined by power and fuel expenses incurred in production process of companies.

ii) *Profits*: Profits are defined by Profit after tax. The expected relationship is high profits imply high production.

iii) *Capital expenses*: It is defined by Net Fixed Assets of the company. If capital expenses are more the production should be more.

iv) *Labor expenses*: It is defined by wages and salaries of the employees. The expected relationship is positive.

v) *Age of the firm:* It is defined as current year minus year of incorporation. The expected relationship could be both positive and negative.

vi) *Repairs expenses*: It is defined as repairs on plant and machinery used in production process. More repairs imply old machinery and less production.

vii) *Technology imports*: It is also an important variable affecting production of companies. More technology imports imply better technology and hence more production.

viii) *PAT*: implying Perform, Achieve and Trade Cycle-I (2012-15) is used in dummy variable form.

ix) *ECA:* implying Energy Conservation Act, 2001 is used in dummy variable form.

Panel Data modelling has been used to estimate Energy intensity of selected industries in India.

To get the most robust/appropriate results in all scenarios, Four Regression Models are applied to both the datasets for all objectives namely,

- *Generalised least square methods (GLS)*
- *Pooled Ordinary Square method (POLS)*
- *Fixed Effect method*
- *Random effect method*

Each of the above regression models is different in its specification and is appropriate to apply to our panel data to get most robust results taking into account various scenarios.

The econometric specification of the model is as follows:

To estimate profitability/profit margin intensity, the model is defined as :

$$PMI = f(EI, A, LI, CI, Si, RI, TMI, PAT, ECA)$$

The specific equation form can be defined as:

$$\ln PMI_{it} = \alpha_1 + \alpha_2 \ln EI_{it} + \alpha_3 \ln A_{it} + \alpha_4 \ln LI_{it} + \alpha_5 \ln CI_{it} + \alpha_6 \ln SI_{it} + \alpha_7 \ln RI_{it} + \alpha_8 \ln TMI_{it} + \beta_1 PAT + \beta_2 ECA + \varepsilon$$

Following is the definition of the variables:

	Dependent Variable	Independent Variable
Model-2	Profitability (PMI)	Energy intensity (EI) Labor intensity (LI) Firm size (S) Repairs intensity (RI) Age of the firm (A) Technology import intensity (TMI) $\begin{Bmatrix} PAT = 1\,; 2012 - 2015 \\ 0; elsewehere \end{Bmatrix}$ $\begin{Bmatrix} ECA = 1\,; 2001 - 2015 \\ 0; elsewehere \end{Bmatrix}$

data set will be balanced data set indexed by i = 1,2,…..k (where, k is no. of companies) and t = 1, 2,.., 21

Model- 3

The econometric specification of the model is as follows:

To estimate production, the model is defined as :

S = f (Energy, Profit, Age, Labor, Capital, Repairs, Techimp, PAT, ECA)

The specific equation form can be defined as:

$$Sales_{it} = \alpha_1 + \alpha_2 Energy_{it} + \alpha_3 Profit_{it} + \alpha_4 Age_{it} + \alpha_5 Labor_{it} + \alpha_6 Capital_{it} + \alpha_7 Repairs_{it} + \alpha_8 Techimp_{it} + \beta_1 PAT + \beta_2 ECA + \varepsilon$$

Where, the variable are described in the following table :

Model	Dependent Variable	Independent Variable
Model-4	Production (S)	Energy Expenses (Energy) Profit Capital expenses (Capital) Labor expenses (Labor)

		Energy expenses (Energy) Age of the firm (Age) Repairs expenses (Repairs) Technology imports (Techimp) PAT {1 = 2012 to 2015, 0 = otherwise} ECA {1 = 2001 to 2015, 0 = otherwise}

The data set will be balanced data set indexed by i = 1,2,…..no. of companies and t = 1, 2,.., 21.

For our whole analysis "Sales" is taken as a proxy for "Production" due to unavailability of data as also used by many other authors in their study namely, Soni and Kapshe (2017), Oak (2017), Sahu and Narayan (2009, 2011, 2014), Goldar (2010), Kumar (2003), UNIDO (2010,2011).

All the variables except Age are in Rs. Million (as extracted from CMIE Prowess). Therefore, in order to correct it for Inflation we have used Index of Industrial Production (IIP) data from Indiastat.com and used the following formula to correct for Inflation :

(Current value of variable/IIP) x 100

5.3 Estimation And Result

5.3.1 Unit-root tests: Since our dataset is a panel data, before proceeding further in our estimation we have to test for stationarity of all the variables used in the analysis, as checking stationarity is one of the important criteria when dealing with time series data, panel data etc. Therefore this step is necessary in order to get accurate results in the analysis. For detailed unit-root test results please refer Chapter 3, section 3.5.8

5.3.2 Regression Results

We have applied four models namely Pooled Ordinary Least Square (OLS), Fixed Effect, Random Effect, Generalised Least Square (GLS).

In order to achieve result with very high accuracy, other seven models each different in their specification were also used for analysis purpose. Results of these are presented in Annexure 5.1, 5.2 and 5.3. The results of the models presented in the annexure are also found to be same/similar as the models presented in the main body of the thesis.

Dataset 1

Table 5.1: Regression results indicating impact on profitability of industries (Lnpmi) for Dataset 1

	Pooled OLS (Lnpmi)	Fixed Effect (Lnpmi)	Random Effect (Lnpmi)	Generalised Least Square (Lnpmi)
Lnei	-.2669411***	-.3444267***	-.323385***	-.2669411***
	-0.05887	-0.08225	-0.07596	-0.05833
Lna	-.0720701***	0.041049	-.0562105**	-.0720701***
	-0.01201	-0.04519	-0.02431	-0.0119
Lnli	0.156452	-0.05386	0.01258	0.156452
	-0.14432	-0.15817	-0.15318	-0.14299
Lnci	0.015604	-0.01821	-0.02007	0.015604
	-0.02411	-0.02451	-0.02398	-0.02388
Lnri	1.511616***	1.129155*	1.007635*	1.511616***
	-0.44509	-0.70842	-0.62915	-0.441
Lnsi	.0098924***	-.0286174***	-0.00524	.0098924***
	-0.00389	-0.0102	-0.0068	-0.00385
Lntmi	0.0251	0.029043	0.031624	0.0251
	-0.03797	-0.04061	-0.03955	-0.03763
_cons	.1920963***	.2304562*	.3280556***	.1920963***
	-0.06354	-0.13321	-0.09861	-0.06296
Pat	-0.01438	-.0246651*	-0.01615	-0.01438
	-0.01413	-0.01365	-0.01278	-0.014
Eca	.0303353**	.0198761*	.0337327***	.0303353**
	-0.03034	-0.01542	-0.01311	-0.01311
Number of obs.	546	546	546	546
Number of groups	26	26	26	26
F	F(9, 536) = 11.22	F(9,511) = 4.42	Wald chi2(9) = 39.76	Wald chi2(9) = 102.89

Prob > F	0	0	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

Table 5.1 shows the impact of all the independent variables on profit margin intensity (dependent variables) taking both the dummy variables PAT and ECA together. As can be seen from Table 5.1, a highly significant and inverse relation is found between profit margin intensity and energy intensity implying an increase in energy intensity will lead to a decline in profit margin intensity of firms.

The logical interpretation behind this could be an increase in energy usage in the process of production will decrease the profit intensity of the companies. According to Pooled OLS Model, when energy intensity rises by 1%, profit margin intensity will decrease by 0.266%. According to Fixed Effect Model, when energy intensity rises by 1%, profit margin intensity will decrease by 0.344%. According to Random Effect Model, when energy intensity increases by 1%, profit margin intensity will decrease by 0.323%. According to GLS Model, when energy intensity rises by 1%, profit margin intensity will decrease by 0.266%.

A significant and negative relation is found between age and profit margin intensity of firms implying with an increase in companies' age its profit margin intensity will decrease may be because as the company grew older its equipments and production methods may become outdated and might become more energy-intensive and thereby reducing its profits. According to Pooled OLS Model, when age rises by 1%, profit margin intensity will decrease by 0.072%. According to Random Effect Model, when age rises by 1%, profit margin intensity will decrease by 0.056%. According to GLS Model, when age rises by 1%, profit margin intensity will decrease by 0.072%.

For the variable labor intensity and capital intensity no significant results have been found. A significant and direct relation has been found between repairs intensity and profit margin intensity implying more expenditure on repairs and machinery by firms leads to more profits for firms as well. According to Pooled OLS Model, when repairs intensity rises by 1%, profit margin intensity rises by 1.511%. According to GLS Model also when repairs intensity rises by 1%, profit margin intensity increases by 1.511%.

We are not able to decide on the exact relation between size and profit margin intensity, as sometimes it is found to be negative and sometimes positive and also found significant with both signs in different models.

No significant relationship has been found between the variable technology import intensity and profits intensity of companies implying not much impact of this variable on profit margin intensity.
The dummy variable representing PAT year has been found weakly significant in very few models and is seemed to be negatively related with energy intensity implying years in which PAT is present profit margin intensity of companies have increased.

But for ECA dummy, the coefficient is found to be significant/weakly significant in most of the models and have seemed to increase profit margin intensity in ECA years of companies implying ECA to have the desired impact on energy intensity of companies and hence profit margin intensity. According to Pooled OLS Model, when there is ECA year, profit margin intensity will increase by 0.03%. According to Fixed Effect Model, when there is ECA year, profit margin intensity will increase by 0.02%. According to Random Effect Model, when there is ECA year, profit margin intensity will increase by 0.33%. According to GLS Model controlling for industry effects, when there is ECA year, profit margin intensity will increase by 0.03%.

Table 5.2: Hausman Test Results for Dataset 1

	Coefficients			
	(b) fixed	(B) Random	(b–B) Difference	sqrt(diag(V_b-V_B)) S.E.
Lna	.0410489	-.0562105	.0972594	.0380965
Lnli	-.0538582	.0125798	-.066438	.0394267
Lnri	1.129155	1.007635	.1215199	.3256291
Lnsi	-.0286174	-.0052397	-.0233776	.0076022
Lnci	-.0182136	-.0200714	.0018578	.0050583

Lntmi	.0290429	.0316238	-.0025809	.0092158
Lnei	-.3444267	-.323385	-.0210417	.0315525
Pat	-.0246651	-.0161547	-.0085105	.0047987
Eca	.0198761	.0337327	-.0138567	.0081291

Source: Author's own calculation

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 23.76

Prob>chi2 = 0.0047

(V_b-V_B is not positive definite)

As per the Hausman test results, the null hypothesis is rejected, hence fixed effect model seems to be most appropriate in this case but in order to get the most robust and appropriate results for our analysis we have applied all the models discussed above.

<u>Dataset 2</u>

Table 5.3: Regression results indicating impact on profitability of industries (Lnpmi) for Dataset 2

Model-I	**Model-III**	**Model-IV**	**Model-V**	**Model-VII**
	Pooled OLS (Lnpmi)	**Fixed Effect (Lnpmi)**	**Random Effect (Lnpmi)**	**Generalised Least Square (Lnpmi)**
Lnei	-.4640543*** (.0492338)	-.4106149*** (.0863746)	-.4214922*** (.0734565)	-.4640543*** (.0490444)
Lna	-.0096929 (.0096682)	-.0791424*** (.0281379)	-.041841** (.0179895)	-.0096929 (.009631)
Lnli	-.3177158** (.1325241)	-1.108547*** (.1521356)	-.8808985*** (.1464623)	-.3177158** (.1320142)
Lnci	-.0737293*** (.0168316)	-.2334842*** (.0192299)	-.1920391*** (.018515)	-.0737293*** (.0167669)

Lnri	1.378035*** (.3532529)	1.530923*** (.4260221)	1.642588*** (.40707)	1.378035*** (.3518937)
Lnsi	.0133727*** (.0030807)	.0094043* (.0057008)	.0101762** (.0045072)	.0133727*** (.0030688)
Lntmi	-.0700587** (.0361767)	.0971013** (.039804)	.0556608 (.0386914)	-.0700587** (.0360375)
_cons	.004871 (.0405611)	.3678896*** (.0815416)	.2077951*** (.0632642)	.004871 (.040405)
Pat	-.0403238*** (.0123117)	-.0199512** (.0109762)	-.0294257** (.0106419)	-.0403238*** (.0122644)
Eca	.0237674** (.0112308)	.0501326*** (.0114055)	.0375444*** (.0103986)	.0237674** (.0111876)
Number of obs.	1302	1302	1302	1302
Number of groups	62	62	62	62
F	F(9, 1292) = 23.00	F(9,1231) = 34.05	Wald chi2(9) = 260.14	Wald chi2(9) = 208.58
Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

As can be seen from Table 5.3, a significant and negative relation is found between energy intensity and profit margin intensity implying an increase in energy intensity will lead to a decline in profit margin intensity of firms. The logical interpretation behind this could be an increase in energy usage in the process of production will decrease the profit intensity of the companies. According to Pooled OLS Model, when energy intensity rises by 1%, profit margin intensity will decrease by 0.464%. According to Fixed Effect Model, when energy intensity rises by 1%, energy intensity will decrease by 0.410%. According to Fixed Effect Model, when energy intensity rises by 1%, energy intensity will decrease by 0.421%. According to GLS Model controlling for industry effects, when energy intensity rises by 1%, profit margin intensity will decrease by 0.484%.

A significant and negative relation is found between age and profit margin intensity of firms implying with an increase in companies' age its profit margin intensity will decrease, may be because as the company grew older its equipments and production methods may become outdated and might become more energy-intensive and thereby reducing its profits. According to Fixed Effect Model, when age rises by 1%, profit margin intensity will decrease by 0.079%. According to Random Effect Model, when age rises by 1%, profit margin intensity will decrease by 0.041%.

A significant and inverse relation is found between the variable labor intensity and profit margin intensity. As labor intensity increases, profit margin intensity decline may be due to redundant labor. According to Pooled OLS Model, when labor intensity rises by 1%, profit margin intensity will decrease by 0.318%. According to Fixed Effect Model, when labor intensity rises by 1%, profit margin intensity will decrease by 1.109%. According to Random Effect Model, when labor intensity rises by 1%, profit margin intensity will decrease by 0.881%. According to GLS Model, when labor intensity rises by 1%, profit margin intensity will decline by 0.317%.

A significant and inverse relation is found between capital intensity and profit margin intensity. As capital intensity increases, profit margin intensity declines may be due to machinery and equipments employed in the production process are consuming more energy and hence decline in profits. According to Pooled OLS Model, when capital intensity rises by 1%, profit margin intensity will decline by 0.074%. According to Fixed Effect Model, when capital intensity rises by 1%, profit margin intensity will decline by 0.233%. According to Random Effect Model, when capital intensity rises by 1%, profit margin intensity will decline by 0.192%. According to GLS Model, when capital intensity rises by 1%, profit margin intensity will decline by 0.074%.

The variable repairs intensity is found to be significantly and directly related to profit margin intensity implying more repairs of plant and machinery means more profits earned by firms as well.

According to Pooled OLS Model, when repairs intensity increases by 1%, profit margin intensity will increase by 1.378%. According to Fixed Effect Model, when repairs intensity rises by 1%, profit margin intensity will also rise by 1.531%. According to Random Effect Model, when repairs intensity rises by 1%, profit margin intensity will also rise by 1.642%. According to GLS Model, when repairs intensity rises by 1%, profit margin intensity will also rise by 1.378%.

The variable firms' size is found to be significantly and directly related to profit margin intensity implying as size of the firm increases profit margin intensity will also increase. According to Pooled OLS model, when size of the firm rises by 1%, profits margin intensity rises by 0.013%. According to Fixed Effect Model, when size of the firm rises by 1%, profits margin intensity rises by 0.009%. According to Random Effect Model, when size of the firm rises by 1%, profits margin intensity rises by 0.010%. According to GLS Model, when size of the firm rises by 1%, profits margin intensity rises by 0.013%.

An exact relationship for the variable technology import intensity could not be found.

The dummy variable representing PAT year has been found to be significant in the models and is seemed to be negatively related with profit margin intensity implying years in which PAT is present profit margin intensity of companies have declined. But for ECA dummy, the coefficient is found to be significant in most of the models and have seemed to increase profit margin intensity in ECA years of companies implying ECA to have the desired impact on energy intensity of companies and hence profit margin intensity. According to Pooled OLS Model, when there is ECA year, profit margin intensity will increase by 0.024%. According to Fixed Effect Model, when there is ECA year, profit margin intensity will increase by 0.050%. According to Random Effect Model, when there is ECA year, profit margin intensity will increase by 0.038%. According to GLS Model, when there is ECA year, profit margin intensity will increase by 0.024%.

Table 5.4: Hausman Test Results for Dataset 2

	Coefficients			
	(b) fixed	(B) Random	(b–B) Difference	sqrt(diag(V_b-V_B)) S.E.
Lna	-.0791424	-.041841	- .0373014	.021636
Lnli	-1.108547	-.8808985	-.2276488	.0411587
Lnri	1.530923	1.642588	-.1116653	.1256539
Lnsi	.0094043	.0101762	-.0007719	.0034906
Lnci	-.2334842	-.1920391	-.0414451	.0051945
Lntmi	.0971013	.0556608	.0414405	.0093452
Lnei	-.4106149	-.4214922	.0108773	.045439

Pat	-.0199512	-.0294257	.0094746	.0026884
Eca	.0501326	.0375444	.0125883	.0046856

Source: Author's own calculation

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 87.24

Prob>chi2 = 0.0000

(V_b-V_B is not positive definite)

As per the Hausman test results, the null hypothesis is rejected, hence fixed effect model seems to be most appropriate in this case but in order to get the most robust and appropriate results for our analysis we have applied all the models discussed above.

Dataset 1

Table 5.5: Regression results indicating impact on production of industries (sales) for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**
	Pooled OLS (sales)	**Fixed Effect (sales)**	**Random Effect (sales)**	**Generalised Least Square (sales)**
energy	.7019173** (.3021217)	-.6923738** (.2874019)	.5287605* (.3045514)	.7019173* (.2993422)
Profits	1.458229*** (.1491512)	.5203754*** (.1389747)	1.360518*** (.147455)	1.458229*** (.147779)
Age	-11.5516* (23.11318)	-20.95599* (145.4551)	-13.60708* (26.83377)	-11.5516* (22.90054)
Labor	5.621188*** (1.135573)	9.167343*** (1.18059)	5.629059*** (1.155184)	5.621188*** (1.125126)
Capital	.0924468*** (.0221411)	-.0208834* (.0196753)	.0798108*** (.0217331)	.0924468*** (.0219374)
Repairs	2.23458* (3.116615)	18.71569*** (3.23357)	5.483151* (3.213326)	2.23458* (3.087943)

Techimp	1.077296*** (.0109747)	1.113572*** (.0100399)	1.081788*** (.010855)	1.077296*** (.0108737)
Pat	2070.888* (1303.791)	1835.305* (1443.183)	2131.099* (1270.603)	2070.888* (1291.796)
Eca	-927.6809* (1142.508)	-207.6838* (1443.978)	-764.3637* 1117.469	-927.6809* (1131.997)
_cons	3692.871*** (1254.78)	4646.96* (5291.05)	3769.563*** (1367.843)	3692.871** (1243.236)
Number of obs.	546	546	546	546
Number of groups	26	26	26	26
F	F(9, 536) =14237.00	F(25,511) =12.74	Wald chi2(9) =5.97e+06	F(34,511) =5841.14
Prob > F	0.0000	0.0000	0.0000	0.0000

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author’s own calculation

As can be seen from Table 5.5, Energy expenses has a significant and direct relation with production implying if energy expenses will increase production will also increase. This may be interpreted as more energy consumption implies more production. According to Pooled OLS Model, when energy expenses rises by 1 unit, sales will decline by 0.701 units. According to Random Effect Model, when energy expenses rises by 1 unit, sales will decline by 0.528 units. According to GLS Model controlling for industry effects, when energy expenses rises by 1 unit, sales will decline by 0.701 units.

There is a significant and direct relation between profits and production implying increase in profits will promote more production. The interpretation of this could be more profits imply more production by the firm. According to Pooled OLS Model, when profits rises by 1 unit, production will also rise by 1.458 units. According to Fixed Effect Model, when profits rises by 1 unit, production will also rise by 0.520 units. According to Random Effect Model, when profits rises by 1 unit, production will also rise by 1.360 units. According to GLS Model, when profits rises by 1 unit, production will also rise by 1.458 units.

The variable age is found to be weakly significant and negatively related with production implying with increase in age of the company its production will decrease, may be because as the company grew older due to outdated technology the production cost increases and hence production level of the firm declines. According to Pooled OLS Model, when firm's age increases by 1 year then, its production falls by 11.551 units. According to Fixed Effect Model, when firm's age rises by 1 year then, its production falls by 20.955 units. According to Random Effect Model, when age of the firm rises by 1 year then, its production falls by 13.607 units. According to GLS Model, when firm's age rises by 1 year then, its production falls by 11.551 units.

The coefficient of labor expenses is found to be significant in almost all the models and also appearing to be positively related with production. More labor means more production. According to Pooled OLS Model, a unit rise in labor expenses will increase production by 5.621 units. According to Fixed Effect Model, a unit rise in labor expenses will increase production by 9.167 units. According to Random Effect Model, a unit rise in labor expenses will increase production by 5.629 units. According to GLS Model, a 1% rise in labor intensity will increase energy intensity by 5.621 units.

A positive and significant relation is found between capital intensity and production implying capital-intensive firms to have more production level. According to Pooled OLS Model, a unit rise in capital expenses will increase production by 0.092 units. According to Random Effect Model, a unit rise in capital expenses will increase production by 0.078 units. According to GLS Model, a unit rise in capital expenses will increase production by 0.092 units.

A positive and weakly significant relationship was found between repairs expenses and production implying more expenditure on repairs of plant and machinery means more production as well. According to Pooled OLS Model, 1 unit increase in repairs expenses will increase production by 2.234 units. According to Fixed Effect Model, 1 unit increase in repairs expenses will increase production by 18.715 units. According to Random Effect Model, 1 unit increase in repairs expenses will increase production by 5.483 units. According to GLS Model, 1 unit increase in repairs expenses will increase production by 2.234units.

A significant and positive relation is found between intensity of technology imports and production. Implying more expenditure on technology imports from abroad will increase production level of firms as well, increasing efficiency in production.

According to Pooled OLS Model, when technology imports increases by 1 unit, production will increase by 1.077 units. According to Fixed Effect Model, when technology import rises by 1 unit, production will also rise by 1.113 units. According to Random Effect Model, when technology imports rises by 1 unit, production will also rise by 1.081 units. According to GLS Model, when technology import rises by 1 unit, production will also rise by 1.077 units.

The dummy variable representing PAT year has been found weakly significant in very few models and is seemed to be positively related with production implying years in which PAT is present production of companies have increased. But for ECA dummy, the coefficient is found to be weakly significant in all of the models and negatively related with production and have seemed to decrease production in ECA years of companies.

Since according to all the models, Prob > F (or Prob > chi2) value is less than 0.05, all models are considered to be statistically fine.

Table 5.6: Hausman Test Results for Dataset 1 (sales)

	Coefficients			
	(b) fixed	(B) Random	(b–B) Difference	sqrt(diag(V_b-V_B)) S.E.
Profit	.5218497	1.374644	-.8527941	.
Energy	-.6890297	.5566666	-1.245696	.
Labor	9.1297	5.531003	3.598696	.1524313
Repairs	18.70493	5.325359	13.37957	.6304437
Capital	-.0208084	.0821187	-.1029271	.
Techimp	1.11368	1.080975	.0327051	.
Pat	1694.997	2039.562	-344.565	.
Eca	-364.7702	-876.6758	511.9057	.

Source: Author’s own calculation

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B) = -12.05

chi2<0 ==> model fitted on these data fails to meet the asymptotic assumptions of the Hausman test

As per the Hausman test results, this test could not be performed on this data as it stated that the model fitted on these data failed to meet the asymptotic assumptions of the Hausman test and hence we have also performed Breusch and Pagan Lagrangian multiplier test (LM Test) on this data in order to find out the most appropriate model. The following are the results.

Table 5.7: Breusch and Pagan Lagrangian multiplier test results for Dataset 1 (sales)

sales[panelid,t] = Xb + u[panelid] + e[panelid,t]

Estimated results:

	Var	sd = sqrt(Var)
Sales	2.79e+10	167105.4
E	7.63e+07	8734.273
U	1437489	1198.953

Source: Author's own calculation

Test: Var(u) = 0

chibar2(01) = 98.92

Prob > chibar2 = 0.0000

As per the results of LM test above, as the null hypothesis is rejected, Random effect model seems to be the most appropriate model in this case, though we have discussed other models as well in order to get the robust and most appropriate results, the results of which are presented above.

Dataset 2

Table 5.8: Regression results indicating impact on production of industries (sales) for Dataset 2

	Model-I	Model-III	Model-V	Model-VII
	Pooled OLS (sales)	**Fixed Effect (sales)**	**Random Effect (sales)**	**Generalised Least Square (sales)**
Energy	.6300656*** (.1127413)	.7810473*** (.1587366)	.8454949*** (.1413479)	.6300656*** (.1123068)
Profits	1.852401*** (.0555192)	1.839369*** (.0595387)	1.883868*** (.0558668)	1.852401*** (.056401)
Age	-9.022813 (11.35071)	294.116*** (68.80514)	18.51094 24.62227	-9.022813 (11.30697)
Labor	1.681176*** (.1486884)	2.14579*** (.1891131)	2.185874*** (.1722621)	1.681176*** (.1481154)
Capital	.4636871*** (.0106716)	.3865621*** (.0136836)	.4184467*** (.0121483)	.4636871*** (.0106305)
Repairs	2.867662*** (.3140072)	2.223498*** (.2723893)	2.355497*** (.2748206)	2.867662*** (.3127971)
Techimp	1.395828*** (.0444165)	1.040254*** (.0526112)	1.109991*** (.0497257)	1.395828*** (.0442454)
Pat	-418.4406 (574.351)	-1886.495*** (681.9703)	-214.7979 (508.969)	-418.4406 (572.1377)
Eca	1658.645** (499.0811)	-292.993 (691.9442)	1729.441*** (456.0525)	1658.645*** (497.1579)
_cons	1033.527* (560.3151)	-8317.919*** (2333.608)	494.2503 (1010.022)	1033.527* (558.1559)
Number of obs.	1300	1300	1300	1300
Number of groups	62	62	62	62
F	F(9,1290) =3522.16	F(9,1229) =779.64	Wald chi2(9) =11421.29	Wald chi2(9) =31945.19
Prob > F	0.000	0.0000	0.0000	0.0000

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

As can be seen from Table 5.8, a positive and significant relationship was found between energy expenses and production of firms implying if energy expenses will rise production will also rise. This may be interpreted as more energy consumption implies more production. According to Pooled OLS Model, when energy expenses rises by 1 unit, sales will also rise by 0.630 units. According to Fixed Effect Model, when energy expenses rises by 1 unit, sales will also rise by 0.781 units. According to Random Effect Model, when energy expenses rises by 1 unit, sales will also rise by 0.845 units. According to GLS Model, when energy expenses rises by 1 unit, sales will also rise by 0.630 units.

A significant and positive relation of profits with production of firms has been found implying increased profits means more production by firms as well. This may be interpreted as more profits implies more production. According to Pooled OLS Model, when profits rises by 1 unit, production will also rise by 1.852 units. According to Fixed Effect Model, when profits rises by 1 unit, sales will also rise by 1.839 units. According to Fixed Effect Model, when profits rises by 1 unit, sales will also rise by 1.883 units. According to GLS Model, when profits rises by 1 unit, sales will also rise by 1.852 units.

The variable age wherever significant appeared to be directly related with production implying with increase in age of the company its production will increase, may be because as the company grew older it get more experienced in market and its production also increases with increase in demand of its products in the market. According to Fixed Effect and GLS models (where it is found significant), a 1 unit increase in age of the company will increase its production by 294.116 units.

The coefficient of labor expenses is found to be significant in almost all the models and also appearing to be positively related with production. More labor means more production. According to Pooled OLS Model, a 1 unit rise in labor expenses will increase production by 1.681 units. According to Fixed Effect Model, a 1 unit rise in labor expenses will increase production by 2.146 units. According to Random Effect Model, a unit rise in labor expenses will increase production by 2.186 units.

According to GLS Model, a unit rise in labor intensity will increase production by 1.681 units.

A direct and significant relation is found between capital intensity and production of firms. According to Pooled OLS Model, a unit increase in capital intensity will increase production by 0.463 units. According to Fixed Effect Model, a unit rise in capital intensity will lead to increase in production by 0.386 units. According to Random Effect Model, a unit rise in capital intensity will lead to increase in production by 0.418 units. According to GLS Model, a unit rise in capital intensity will lead to increase in production by 0.463 units.

A direct and significant relation between repairs expenses and production of firms implying more expenditure on repairs of plant and machinery means more production of firms. According to Pooled OLS Model, 1 unit rise in repairs expenses will lead to increase in production by 2.867 units. According to Fixed Effect Model, 1 unit rise in repairs expenses will lead to an increase production by 2.223 units. According to Random Effect Model, 1 unit rise in repairs expenses will lead to an increase in production by 2.355 units. According to GLS Model, 1 unit rise in repairs expenses will lead to an increase production by 2.867 units.

A significant and direct relation is found between technology import intensity and production of firms implying more expenditure on technology imports from abroad will raise the level of production of firms as well, increasing efficiency in production. According to Pooled OLS Model, when technology import rises by 1 unit, it will also lead to an increase in production by 1.396 units. According to Fixed Effect Model, when technology import rises by 1 unit, it will lead to an increase in production by 1.040 units. According to Random Effect Model, when technology import rises by 1 unit, it will lead to increase in production by 1.109 units. According to GLS Model, when technology import rises by 1 unit, it will lead to an increase in production by 1.396 units.

The dummy variable representing PAT year has being found significant in very few models and is seemed to be negatively related with production implying years in which PAT is present production of companies have declined. But for ECA dummy, the coefficient is found to be significant in most of the models and have seemed to increase production in ECA years of companies implying ECA to have the desired impact on production of companies. According to Pooled OLS Model, when there is ECA year, production will increase by 1658.645 units. According to Random Effect Model, when there is ECA year, production will increase by 1729.441 units. According to GLS Model, when there is ECA year, production will increase by 1658.645 units.

Since according to all the models, Prob > F (or Prob > chi2) value is less than 0.05, all models are considered to be statistically fine.

Table 5.9: Hausman Test Results for Dataset 2 (sales)

	Coefficients			
	(b) fixed	(B) Random	(b–B) Difference	sqrt(diag(V_b-V_B)) S.E.
Profit	1.845291	1.88436	-.0390698	.0217626
Energy	.8296673	.8440829	-.0144156	.0739034
Labor	2.183508	2.200414	-.0169065	.0832031
Repairs	2.217483	2.365465	-.1479826	.
Capital	.3891751	.4179685	-.0287934	.0065246
Techimp	1.064087	1.11036	-.0462734	.0174359
Pat	226.829	-79.57835	306.4073	.
Eca	2108.237	1877.808	230.4292	.

Source: Author's own calculation

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 62.80

Prob>chi2 = 0.0000 (V_b-V_B is not positive definite)

As per the Hausman test results, the null hypothesis is rejected, hence fixed effect model seems to be most appropriate in this case but in order to get the most robust and appropriate results for our analysis we have applied all the models discussed above.

5.4 Conclusion

The results of our study are summarized as follows:

Table 5.10: Results Consolidation representing impact on profitability of industries

Objective 2 (i)	***Dataset 1 (Aluminium/Chlor-Alkali/Textiles)***	***Dataset 2 (Cement/Iron and Steel/Fertilizer/Pulp and Paper/Thermal Power Plants)***
	Profit Margin Intensity (lnpmi)	***Profit Margin Intensity (lnpmi)***
Energy Intensity (lnei)	Negative/Significant	Negative/Significant
Age (lna)	Negative/Significant	Negative/Significant few models
Labor Intensity (lnli)	Positive/Negative/Not Significant	Negative/Significant
Capital Intensity (lnci)	Positive/Negative/Not Significant	Negative/Significant
Repairs Intensity (lnri)	Positive/Significant few models	Positive/Significant
Size (lnsi)	Positive/Negative/ Significant	Positive/Significant
Technology Import Intensity (lntmi)	Positive/Not Significant	Negative/Positive/Significant few models
Constant term	Positive/Significant	Positive/Significant
PAT	Negative/Significant few models	Negative/Significant
ECA	Positive/Significant	Positive/Significant

Source: Author's own work

As can be seen from table 5.10, energy intensity is found to be a significant variable affecting profit margin intensity of energy-intensive industries for both the datasets. As this is the basis of our study this result is of utmost importance. Energy cost forms a major proportion of total production cost in these energy-intensive industries. The same is also very much highlighted by our results. A negative and significant relation was found between energy intensity (energy cost) and profit margin intensity (profits) implying as the company energy intensity/cost will decline it will earn more profits and hence will be more competitive in the market.

The results of the analysis are not very significant, few variables are significant, some of them are age, repairs intensity, PAT and ECA.

There is a significant and indirect relation between age and profit margin intensity of firms implying as age of the firm increases profit margin intensity declines or in other words profit margin intensity is high for newly constructed companies may be because older firms are using outdated technology to produce, also, old machinery and equipments requires more energy and maintenance thereby increasing the production cost and reducing profits.

For the variable repairs intensity, a positive and significant relationship is found with profit margin intensity implying a firm indulging in more repairs of plant and machinery will also be more energy consuming and hence reducing profits as cost of energy forms a huge percentage of total production cost of energy-intensive industries as highlighted in the text earlier.

PAT is significant and appeared to be indirectly related to profit margin intensity implying due to implementation of PAT mechanism profits of the firms have declined. This result is not in line with our expectation.

Initially we found that PAT is adversely related to profit margin intensity. This is bit surprising at first sight but it may be interpreted in the sense that companies are making huge investments in advancement of technology for meeting PAT targets and gaining energy efficiency in the beginning which can be detrimental to profits margin but in the long run it may be beneficial to the companies increasing their profitability and hence competitiveness in the market.

Whereas in case of ECA, it is found to be favorably affecting profit margin intensity, increasing it and highly significant. As per government records, Energy Conservation Act (ECA), 2001 reduced energy consumption of the economy by around 12 mtoe or 18000 million kWh reducing equivalent electricity generation by approx. 4GW or equivalent investment by approx. 20000 crore rupees between 2007 and 2010. The act was amended and strengthened in 2010 (Tata Strategic, 2014). Therefore, this Act have reduced the energy intensity of the Indian economy as a whole and may of industries as part of it thereby increasing its profits and hence competitiveness.

As per Bureau of Energy Efficiency, PAT Cycle-I (2012-15) led to an energy savings of 8.67 million toe against the target of 6.68 million toe. Also, 32 million tonnes of CO_2 emissions have been reduced. But this is not in consent with our findings. It is also too early too judge its effectiveness as only its first cycle, 2012-15 has ended, not a very old policy measure in India.

Hence, a lot of amendments needs to be done in PAT further cycles at both policy formation and implementation level, also stricter norms need to be set to bring about real change in industrial energy intensity and for it to be called an effective policy measure in India.

Table 5.11: Results Consolidation representing impact on production (sales) of industries

Objective 2 (ii)	*Dataset 1 (Aluminium/Chlor-Alkali/Textiles)*	*Dataset 2 (Cement/Iron and Steel/Fertilizer/Pulp and Paper/Thermal Power Plants)*
	Production	***Production***
energy	Positive/Negative/Significant	Positive/Significant
Profits	Positive/Significant	Positive/Significant
Age	Negative/Weakly Significant	Positive/Significant
Labor	Positive/Significant	Positive/Significant
Capital	Positive/Significant	Positive/Significant
Repairs	Positive/Significant	Positive/Significant
Techimp	Positive/Significant	Positive/Significant
_cons	Positive/Significant	Negative/Significant
PAT	Positive/ Weakly Significant	Negative/Significant few models
ECA	Negative/Weakly Significant	Positive/Significant

Source: Author's own work

Table 5.11 shows the relation between the production (dependent variable) with 9 independent variables in terms of their original unit of data. For the both the data set energy is positively related with production which is also found significant in our analysis. It is quite obvious that if energy expenses are increasing then total production of the company will also increase because energy is used as input in the production process.

As energy, profit is positively related with production as well and also found highly significant in our analysis. If companies earn more profits by producing any commodity then companies increase its production in order to get more and more profit. In other way, more production leads to more profit.

Table 5.11 shows labour expenses and production are positively related and labour as a very useful variable in estimating production level. It is seen practically as well as theoretically in the literature that if there are more expenses on labour means more production as well. In short, production in these industries is labour intensive.

As can be seen from the Table 5.11, repairs expenses is found be significant and positively related to production implying as companies indulge in more repairs of machinery and equipments production level increases. More expenses on repairs/maintenance implies more number of machines and we have already highlighted that more machines implies more production therefore more expenses on repairs gives evidence of more production.

Also it can be seen from the Table 5.11 that technology imports expenses is positively and significantly related to production level implying importing more technology is beneficial to the company and increases its production level. It is difficult to ascertain the impact of PAT and ECA on production from the results achieved as there is no definite result.

CHAPTER 6

ESTIMATION OF EMISSIONS INTENSITY IN ENERGY-INTENSIVE INDUSTRIES IN INDIA

6.0 Introduction

The growth process in all sectors of the economy is driven by the industries which is the most prominent sector contributing to GDP of India. Industry sector contributes around 29.73 percent of our GDP (MoSPI, 2018-19). Being high in energy consumption, of the aggregate commercial energy consumption in India, industrial sector accounts for around 50 percent consumption. Among the industrial sector, the industries like thermal power plants, iron and steel, pulp and paper, textiles, cement, fertilizers, chlor alkali etc. consumes greater than 60 percent of the aggregate energy consumed by industries in India (BEE, 2011).

India holds the third position as fossil fuels consumer (primary energy) in the world (BP SRWE, 2016). The aggregate consumption of primary energy in India was around 100 mtoe (The ET, January 27, 2017). The industrial sector in India consumed about 30 percent (185 Mtoe) of the total final energy consumption of around 527 Mtoe in 2013. (India Energy Outlook, IEA, 2015). In the list of GHG emitters in the world, India holds third rank after China and U.S. in 2016, with its greenhouse gas emissions increasing at a high rate of 4.7 percent in comparison to the last year (PBL, September 29, 2017). One fourth of total GHG emissions in India is contributed by industries (Gupta et al. 2017).

As per Business Line article dated December 6, 2018, the fourth highest emitter of carbon-dioxide in the world is India after China, US and European Union. It accounts for 7% of global emissions in 2017. Industries contribute around one fourth of India's total GHG emissions. Industrial Emissions Grew 8.89 Percent Annually from 2005-2013 (Gupta and Biswas, 2017).

As per a study, from 2010 to 2030 for cement industry electricity savings and associated emissions reduction are 83 TWh and 82 Mt CO_2 respectively. Also, fuel savings and associated emissions reduction are 1029 PJ and 97 Mt CO_2 respectively. In Indian steel sector, from 2010 to 2030, electricity savings and associated emissions reduction are 66 TWh and 65 Mt CO_2 respectively. Also, fuel savings and associated emissions reduction are 768 PJ and 67 Mt CO_2 respectively (Morrow et al., 2013).

As per IEA (2007), improvement in energy efficiency will lead to benefit of energy security, industry competitiveness and environmental benefits such as reduction in CO_2. Countries are under tremendous pressure to clean pollution from industry and limits its growth.

Energy efficiency turned out to be an important tool to reduce energy intensity and emission intensity in the economy.

India's nationally determined contributions (NDCs) are the nation's climate change plans under the Paris Agreement. It defines three major goals :

(i) The share of non-fossil fuels should increase to 40% of the total capacity of electricity generation in India
(ii) To reduce the emission intensity in India by 33% - 35% by 2030 as per 2005 level
(iii) To create additional carbon sink by forest and tree cover of 2.5-3 billion tonnes of CO_2 equivalent

Results show India is keeping its temperature increase below 2 degree Celsius in accordance to its Paris Agreement goal. The recent assessment shows India is very likely to meet its targets of Paris climate pledges before the deadline, specifically its targets of increasing non-fossil fuel generation capacity and reducing emission intensity.

As these international forum commitments are becoming more important day-by-day in current climate change scenario, it is important to study how much energy-intensive industries is contributing to fulfilling these commitments, impact of policy initiatives on these industries.

6.1 Literature Review

There are few studies talking about the emission intensity of industries which we could find in literature but there is no study on impact of policy initiatives on emission intensity of Indian industries.

An increase in energy intensity leads higher emission intensity. Also, higher emission intensive industries are capital intensive and less emission intensive industries are labour-intensive. This leads to a question regarding use of technology in manufacturing industries particularly high emission intensive. Indian manufacturing sector doesn't support Environmental Kuznets Curve (Ranjan, 2015).

If India wants to generate the equal level of output as China generates, India would require double amount of energy it is currently using. Highest level of energy intensity in India is of Iron and steel and non-metallic minerals sectors (Pappas and Chalvatiz, 2016)

The characteristics of firm like energy intensity, age, size plays an important role in the variation of energy intensity of companies. Further, it is also found that technology intensity, capital intensity, labor intensity are also responsible factors affecting CO_2 emission intensity of Indian manufacturing firms (Kumar and Meena, 2017). Inter-firm energy and emission intensity differences are also found by Sahu and Mehta, 2015 in their study. They also found out that more energy intensive industries are also emission intensive. It has been seen in the literature, both small and large sized companies are more energy intensive as well as emission intensive as compared to medium sized companies. Doonan et. al. (2005) and Nowogorska (2013) found regulatory intervention to be an important determinant of environmental performance.

Kim and Worrell (2002) carried out the decomposition analysis to study the trend of CO_2 emissions in steel and iron sector of seven countries including both developed and industrialized countries like United States and developing countries like India, Brazil etc.They found that development in energy intensity is linked to change in technology, consequently incorporated in policies. Energy efficiency was found to be the most important factor behind decline in energy intensity in all countries and also increased or decreased production level affects emission intensities in most of the countries.

As per the literature we know that a long term relationship exists among CO_2 emissions, energy consumption, economics activity and trade. Several empirical results support that energy consumption drives economics activity in short run as well. More energy demand is associated with economics growth. Also, CO_2 emissions are the one way cause for energy consumption in short run and CO_2 emissions to economic growth (Srinivasan ,2014).

There is hardly any study on impact of policy intervention on emission intensity of Indian industries which we could find in literature, hence this objective aims to study the impact of PAT and ECA, 2001 on emission intensity of energy-intensive industries in India which is also one of the indicator of performance of these industries, the overall objective of this research.

6.2 Methodology

To achieve the above objective following methodology is followed:

We have considered all the eight sectors included under PAT Mechanism, Cycle-I (2012-15) namely Aluminum, Cement, Chlor-Alkali, Fertilizers, Iron & Steel, Pulp & Paper, Textiles and Thermal Power Plants. Under PAT, plants of various companies have been included but since plant level data is not available, we have taken firm level data (company level data) for our analysis.
Based on their energy consumption to be called a Designated Consumer under PAT, these sectors are divided into two datasets based on PAT Booklet, Ministry of Power, Government of India, July, 2012. This also needs to be done to overcome the problem of availability of data only for few companies covered under PAT on CMIE Prowess. Under each sector certain companies for which data is available are included in the study and these companies are also covered under PAT Cycle-I. For details regarding companies included in the study you can refer the detailed methodology in Chapter 3 of this thesis.

We have taken time period 1995-2015 in this study because it is required to study the impact of ECA-2001 and PAT Cycle-I (2012-2015) on energy intensity, profitability and emission intensity of industries.

The variables affecting Emission intensity of firms included in this study are:

i) *Energy intensity*: It is the most important variable affecting emission intensity of firms. More energy usage implies more emissions in the atmosphere. It is defined as the ratio of expanses on power and fuel to sales. This variable has been highlighted by many authors in their analysis namely Sahu and Narayan (2013), Kim and Worrell (2002), Nowogorska (2013), Kumar and Meena (2017).

ii) *Profits Margin intensity (Profitability)*: It is also an important variable affecting emissions of the companies. It is defined as the ratio of profit (excluding taxes) to sales. More profits imply more investment in energy efficiency technology by the companies and hence less emissions.

iii) *Capital Intensity*: It is a variable affecting emissions intensity of industries. This variable has been used by Sahu and Narayan (2013), Nowogorska (2013), Kumar and Meena (2017) for their analysis. Emissions by a firm is positively related to capital intensity. This variable is defined as Net Fixed Assets as a proportion of Sales.

iv) *Labor intensity:* Labor intensity is also a variable affecting emissions by firms. This variable has been used by Sahu and Narayan (2013), Kumar and Meena (2017) for their analysis. Ideally, more labor use in production process implies less emissions by the companies. It is defined as ratio of wages and salaries to sales.

v) *Firm size:* It is defined as sum total of sales and total assets of a company in last three years. Firm size is a variable affecting emission intensity of firms. This variable has been used by many authors for their analysis such as Sahu and Narayan (2013), Oak (2017), Nowogorska (2013), Kumar and Meena (2017). It can affect emissions of companies both directly and indirectly.

vi) *Age of the firm:* This variable is defined as current year minus age of incorporation of the company. Another important variable affecting emission intensity of industries is age of the firm. This variable has been used by many authors in their analysis such as Sahu and Narayan (2013), Oak (2017), Nowogorska (2013), Kumar and Meena (2017). There should be directly proportional relationship between emission intensity and age of the firm.

Technology import intensity :

x) *Technology import intensity:* This variable is defined as the ratio of the sum (of foreign exchange spent on capital goods, royalties, raw materials and technical-how paid by the companies to foreign collaborations) to sales. Technology import intensity is also a variable affecting emission intensity of firms. It is also highlighted by various authors in their analysis namely Sahu and Narayan (2013), Oak (2017), Nowogorska (2013), Kumar and Meena (2017). Ideally, more technology imports should imply less emissions by the companies.

xi) *Repairs intensity:* This variable is defined as the ratio of expenditure of repairs on plant and machinery to sales. High repairs of plant and machinery implies more energy intensity and hence more emissions by companies.

xii) *PAT:* Perform, Achieve and Trade I-cycle for the year 2012-2015 is used in dummy variable form.

xiii) *ECA:* implying Energy Conservation Act, 2001 is used in dummy variable form.

Due to unavailability of production data on CMIE Prowess we have taken "Sales" as a proxy for "Production" for our analysis. All the variables except Age are in Rs. Million (as extracted from CMIE Prowess). Therefore, in order to correct it for Inflation we have used Index of Industrial Production (IIP) data (from Indiastat.com and used the following formula to correct for Inflation :

(Current value of variable/IIP) x 100

All the variables are also converted into its natural logarithmic form in order to calculate percentage change directly and to ease the interpretation of results.

Panel Data modelling has been used to estimate Energy intensity of selected industries in India.

To get the most robust/appropriate results in all scenarios, Four Regression Models are applied to both the datasets for all objectives namely,

- Pooled Ordinary Least Square (OLS)
- Fixed Effect
- Random Effect
- Generalised Least Square (GLS)

Each of the above regression models is different in its specification and is appropriate to apply to our panel data to get most robust results taking into account various scenarios.

The econometric specification of the model is as follows:

To estimate emission intensity the model is defined as :

EMI = f(EI, PMI, A, LI, CI, RI, Si, TMI, PAT, ECA)

The specific equation form can be defined as:

$\ln EMI_{it} = \alpha_1 + \alpha_2 \ln EI_{it} + \alpha_3 \ln PMI_{it} + \alpha_4 \ln A_{it} + \alpha_5 \ln LI_{it} + \alpha_6 \ln CI_{it} + \alpha_7 \ln RI_{it} + \alpha_8 \ln SI_{it} + \alpha_9 \ln TMI_{it} + \beta_1 PAT + \beta_2 ECA + \varepsilon$

where, the variable used in model as :

Model	Dependent Variable	Independent Variable
Model-4	Emission Intensity/Carbon-dioxide emissions* (EMI)	Capital intensity (CI) Labor intensity (LI) Energy intensity (EI) Firm size (S) Age of the firm (A) Repairs intensity (RI) Technology import intensity (TMI) $\begin{Bmatrix} PAT = 1\,; 2012 - 2015 \\ 0; elsewehere \end{Bmatrix}$ $\begin{Bmatrix} ECA = 1\,; 2001 - 2015 \\ 0; elsewehere \end{Bmatrix}$

*Carbon dioxide emissions at firm level is calculated using GHG Conversion factors formula for company reporting, 2016 given by department of energy and climate change (DECC). The following formula is used:

$$Emissions\ on\ GHG = Activity\ Data\ \times Emission\ Conversion\ Factor$$

$$Total\ Emissions\ (K_g\ CO_2e) = Energy\ Consumption\ \times Emission\ Factor$$

The data set will be balanced data set indexed by i = 1,2,….k (where, k is no. of companies) and t = 1, 2,.., 21

For our whole analysis "Sales" is taken as a proxy for "Production" due to unavailability of data as also used by many other authors in their study namely, Soni and Kapshe (2017), Oak (2017), Sahu and Narayan (2009, 2011, 2014), Goldar (2010), Kumar (2003), UNIDO (2010,2011).

6.3 Estimation And Result

6.3.1 Unit-root tests: Since our dataset is a panel data, before proceeding further in our estimation the first step is to test for the stationarity of all the variables used in the analysis. This step is necessary in order to get accurate results in the analysis. For detailed unit-root test results please refer Chapter 3, section 3.5.8

6.3.1 Regression Results

We have applied four models namely Pooled Ordinary Least Square (OLS), Fixed Effect, Random Effect, Generalised Least Square (GLS). There are other seven models, each different in their specification were also used for analysis purpose in order to get the most accurate results. Results of these are presented in Annexure 6.1. The results of the models presented in annexure are also found to be same/similar as the models presented in the main body of this thesis.

<u>Dataset 1</u>

Table 6.1: Regression results indicating impact on emission intensity (Lnemi) of industries for Dataset 1

	Model-I	**Model-III**	**Model-V**	**Model-VII**
	Pooled OLS (Lnemi)	**Fixed Effect (Lnemi)**	**Random Effect (Lnemi)**	**Generalised Least Square (Lnemi)**
Lnei	-.4636006 (1.129215)	-2.392437** (.9158751)	-2.239846* (.8893524)	-.4636006 (.8193903)
Lnpmi	1.129215 (1.129215)	.4556964 (.4843362)	.568843 (.4791031)	1.129215** (.5899452)
Lna	.0909022 (.1712159)	.6414596 (.4951746)	.3184875 (.3630028)	.0909022 (.1694824)
Lnli	12.98139*** (1.993474)	3.248528* (1.731966)	3.968927** (1.710944)	12.98139*** (1.973291)
Lnci	.7116882** (.3327434)	.5353514** (.2684497)	.5092424** (.2662276)	.7116882** (.3293745)
Lnri	-7.068564 (.0539676)	10.46764 (7.775462)	7.704346 (7.417708)	-7.068564 (6.141421)
Lnsi	-.2565915*** (.0539676)	-.688268*** (.1125495)	-.5731318*** (.0917441)	-.2565915*** (.0534212)
Lntmi	.7686732 (.5241875)	.9810479** (.4448684)	.989041** (.4406329)	.7686732 (.5188803)
Pat	-5.914929*** (.1950967)	-.5533*** (.1499625)	-.5414081*** (.144058)	-.5914929 (.1931214)
Eca	-.7527454*** (.1834169)	-.405093** (.1691487)	-.395181* (.154788)	-.7527454*** (.1815599)
_cons	15.54597*** (.8842086)	18.36792*** (1.462685)	18.33051*** (1.290781)	15.54597*** (.8752564)

Number of obs.	546	546	546	546
Number of groups	26	26	26	26
F/ Wald chi2	F(10,535) =546	F(10,510) =13.24	Wald chi2(10) =130.65	Wald chi(10) =122.84
Prob > F/ Prob > chi2	0.0000	0.0000	0.0000	0.0000

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

As can be seen from Table 6.1, no significant relationship is found between energy intensity and emissions. Wherever significant, profit margin intensity turned out be directly affecting emission intensity implying increase in profits will lead to increase in emission intensity may be because highly profitable companies are using more of fuels. According to GLS Model (where it is found significant), when profit margin intensity increases by 1%, emission intensity will increase by 1.129%. Though it is insignificant in almost all the models. The variable age is found to be insignificant in all the models and appearing to be directly related with emission intensity.

The result shows a significant direct relationship of labor intensity with emission intensity, may be the reason being redundant labor use in companies.

According to Pooled OLS Model, when labor intensity rises by 1%, emission intensity increases by 12.981%. According to GLS Model, when labor intensity rises by 1%, emission intensity rises by 12.981%. A significant and positive relation is also found between capital intensity and emissions intensity implying more equipment use means more emissions as machinery runs on fuel or energy only. According to Pooled OLS Model, when capital intensity rises by 1%, emission intensity rises by 0.712%. According to Fixed Effect Model, when capital intensity increases by 1%, emission intensity rises by 0.0535%. According to Random Effect Model, when capital intensity rises by 1%, emission intensity rises by 0.509%. According to GLS Model, when capital intensity rises by 1%, emission intensity rises by 0.712%.

The variable of repairs intensity is found to be insignificant in all models.

A significant and negative relation is found between the variable firm's size and emission intensity implying as the companies grow in size in terms of sales and assets they might start investing in emission reducing technologies. According to Pooled OLS Model, when firm's size rises by 1%, emission intensity decreases by 0.256%.

According to Fixed Effect Model, when firm's size rises by 1%, emission intensity decreases by 0.688%. According to Random Effect Model, when size rises by 1%, emission intensity decreases by 0.573%. According to GLS Model, when size rises by 1%, emission intensity decreases by 0.256%.

The coefficient of technological import intensity is found to be positively related with emission intensity. In few models, the relationship is significant. According to Fixed Effect Model, when technology import intensity increases by 1%, emission intensity increases by 0.981%. According to Random Effect Model, when technology import intensity increases by 1%, emission intensity increases by 0.989%.

The dummy variable representing PAT year has been found to be significant in all models and is seemed to be negatively related with emission intensity implying years in which PAT is present emission intensity of companies have increased which is a very good result and in line with our expectation. According to Pooled OLS Model, when there is PAT year, emission intensity will reduce by 0.591%. According to Fixed Effect Model, when there is PAT year, emission intensity will reduce by 0.553%. According to Random Effect model, when there is PAT year, emission intensity will reduce by 0.541%.

And also for ECA dummy, the coefficient is found to be significant in most of the models and have seemed to reduce emission intensity in ECA years of companies implying ECA to have the desired impact on emission intensity of companies. According to Pooled OLS Model, when there is ECA year, emission intensity will reduce by 0.752%. According to Fixed Effect Model, when there is ECA year, emission intensity will reduce by 0.405%. According to Random Effect Model, when there is ECA year, emission intensity will reduce by 0.395%. According to GLS Model, when there is ECA year, emission intensity will reduce by 0.752%.

Table 6.2: Hausman Test Results for Dataset 1 (Lnemi)

	Coefficients			
	(b) fixed	(B) Random	(b–B) Difference	sqrt(diag(V_b-V_B)) S.E.

Lnei	-2.393437	-2.239846	-.1535911	.2188142
Lna	.6414596	.3184875	.3229721	.3367891
Lnpmi	.4556964	.568843	-.1131466	.0710059
Lnli	3.248528	3.968927	-.7203988	.2690263
Lnri	10.46764	7.704346	2.763291	2.331399
Lnsi	-.6882668	-.5731318	-.115135	.065195
Lnci	.5353514	.5092424	.026109	.0344686
Lntmi	.9810479	.989041	-.0079931	.061242
Pat	-.5533	-5414081	-.0118919	.0416661
Eca	-.405093	-.395181	-.0099119	.0682053

Source: Author's own calculation

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 25.94

Prob>chi2 = 0.0038 (V_b-V_B is not positive definite)

As per the Hausman test results, the null hypothesis is rejected, hence fixed effect model seems to be most appropriate in this case but in order to get the most robust and appropriate results for our analysis we have applied all the models discussed above.

Dataset 2

Table 6.3: Regression results indicating impact on emission intensity (Lnemi) of industries for Dataset 2

	Model-I	**Model-III**	**Model-V**	**Model-VII**
	Pooled OLS (lnemi)	**Fixed Effect (lnemi)**	**Random Effect (lnemi)**	**Generalised Least Square**

				(lnemi)
Lnei	-.4036376* (.159791.5)	-.7559386** (.3043605)	-.5544198** (.2071476)	-.4036376** (.1590424)
Lnpmi	-.1396546 (.8570289)	-.1929141** (.9568414)	-.4640231 (.9121902)	-.1396546 (.8530113)
Lna	-.2267779*** (.3063831)	-.8022368*** (.9632966)	-.3092043*** (.4246621)	-.2267779*** (.3049468)
Lnli	.9880712* (.4212692)	.1702864 (.530818)	.8760643* (.4771141)	.9880712** (.4192944)
Lnci	-.1080787* (.6013146)	-.2295939*** (.7117897)	-.1318309** (.6600164)	-.1080787* (.5984957)
Lnri	.6082043 (.1133157)	-.469335 (.1478181)	.6626144 (.1311669)	.6082043 (.1127845)
Lnsi	-.7688742*** (.1008415)	-.1812368*** (.1930549)	-.1217505*** (.1264199)	-.7688742*** (.1003687)
Lntmi	-.601902 (.1192255)	-.1717151 (141098.8)	-.628237 (.1309764)	-.601902 (.1186666)
Pat	.6234178 (.3911935)	.2217543*** (38344.71)	.9580593** (.3774669)	.6234178 (.3893596)
Eca	.6007452 (.354363)	.2442949*** (.4011806)	.5468021 (.3523231)	.6007452 (.3527018)
-cons	.1659246*** (.129096.3)	.4773479*** (.2759757)	.2415501*** (.1672284)	.1659246*** (.1284911)
Number of obs.	1176	1176	1176	1176
Number of groups	56	56	56	56
F/ Wald chi2	F(10,1165) =16.36	F(10,1110) =38.94	Wald chi2(10)	Wald chis(10) =165.19
Prob > F/ Prob > chi2	0.0000	0.0000	0.0000	0.0000

Note - Level of Significance 5% - **, 10% - *, 1% - ***

Source: Author's own calculation

As can be seen from Table 6.3, a significant and negative relation appeared between energy intensity and emission intensity implying if energy intensity will increase emissions will decline. Though this result is not in line with our expectation. According to Fixed Effect Model, when energy intensity increases by 1%, emission intensity reduces by 0.756 percent. According to Random Effect Model, when energy intensity increases by 1%, emission intensity reduces by 0.554 percent. According to GLS Model, when energy intensity increases by 1%, emission intensity reduces by 0.404 percent.

Only in some models, profit margin intensity variable is found to be significant and inversely related to emission intensity implying increase in profits will result in decline in emission intensity may be because highly profitable companies are using more of emission reducing technology in production. It is found to be significant in Fixed Effect Model. According to Fixed Effect Model, when profit margin intensity increases by 1%, emission intensity will reduce by 0.193%.

A significant and inverse relation is found between the variable age and emission intensity of industries implying as the companies get older they might start investing in emission reducing technologies. According to Pooled OLS model, when age rises by 1%, then emission intensity will reduce by 0.227%. According to Fixed Effect Model, when age rises by 1%, emission intensity will reduce by 0.802%. According to Random Effect Model, when age rises by 1%, emission intensity will reduce by 0.309%. According to GLS Model, when age rises by 1%, emission intensity will reduce 0.227%.

Only in few models, a significant and direct relation is found between emission intensity and labor intensity, may be the reason being redundant labor use in companies. Again the variable capital intensity is significant and negatively related with emission intensity only in few models implying more equipment use means lesser emissions. According to Fixed Effect Model, when capital intensity rises by 1%, emission intensity reduces by 0.229%. According to Random Effect Model, when capital intensity rises by 1%, emission intensity reduces by 0.132%.

We are not able to decide on the exact relation between emission intensity and repairs intensity, as sometimes it is found to be negative and sometimes positive and also found insignificant in all the models. No significant relationship is found between the variable emission intensity and technology import intensity. The dummy variable representing PAT year and ECA year has found to be insignificant in most of the models.

Table 6.4: Hausman Test Results for Dataset 2 (Lnemi)

	Coefficients			
	(b) fixed	(B) Random	(b–B) Difference	sqrt(diag(V_b-V_B)) S.E.
Lnei	-282094.1	-137818.2	-144275.9	263087.7
Lna	-310703.4	-104159.6	-206543.8	103390.1
Lnpmi	-14317.48	22313.16	-36630.63	58224.75
Lnli	313950.7	247557	66393.75	376261.3
Lnri	31326.21	-784348.5	815674.7	1016843
Lnsi	-9104.113	-5623.985	-3480.128	18969
Lnci	-184004.1	-107799.3	-76204.77	48363.46
Lntmi	-70231	43958.84	-114189.8	83012.42
Pat	60402.78	20111.42	40291.36	16431.21
Eca	1166.461	-57609.74	58776.2	25593.97

Source: Author's own calculation

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 13.19

Prob>chi2 = 0.2135 (V_b-V_B is not positive definite)

As per the Hausman test results, the null hypothesis is not rejected, hence random effect model seems to be most appropriate in this case but in order to get the most robust and appropriate results for our analysis we have applied all the models discussed above.

Also, in order to decide which model is more appropriate between pooled OLS and random effect model, we conducted Breusch-Pagan Lagrange Multiplier test (LM test), following are the results.

Table 6.5: Breusch-Pagan Lagrange Multiplier Test results for Dataset 2 (Lnemi)

lnemi[panelid,t] = Xb + u[panelid] + e[panelid,t]

Estimated results:

	Var	sd = sqrt(Var)
Lnemi	2.74e+11	523158.4
E	2.57e+11	506832.4
U	1.49e+10	122116.7

Source: Author’s own calculation

Test: Var(u) = 0

chibar2(01) = 23.27

Prob > chibar2 = 0.0000

As per the results of LM test, the null hypothesis is rejected, hence random effect model seems to be most appropriate for Dataset 2 but in order to get the the most robust and appropriate results for our analysis we have applied all the models discussed above.

6.4 Conclusion

The results of our study are summarized as follows:

Table 6.6: Results Consolidation representing impact on emission intensity of industries

Objective 3	**Data set-1 (Aluminium /Chlor-A-Alkali/ Textile)**	**Data set-2 (Cement / Iron & Steel / Fertilizer / Pulp & Paper / Thermal Power Plant**
	Emission Intensity (LnEMI)	**Emission Intensity (LnEMI)**
Energy Intensity	Negative / Significant	Negative / Significant

(LnEI)	in few models	
Profit Margin Intensity (LnPMI)	Positive / Significant few models	Negative / Significant in few models
Age (LnA)	Positive / insignificant	Negative / Significant
Labor Intensity (Lnli)	Positive / Significant	Positive / Significant in few models
Capital Intensity (LnCI)	Positive / Significant	Negative / Significant
Repair Intensity (LnRI)	Positive / Negative / Significant	Positive / Negative / Significant
Size (LnSI)	Negative / Significant	Negative / Significant
Technology Import Intensity (LnTMI)	Positive / Significant few models	Negative / Insignificant
Constant Term	Positive / Significant	Positive / Significant
PAT	Negative / Significant	Positive / Significant in few models
ECA	Negative / Significant	Positive / Significant in few models

Source: Author's own work

As can be seen from table 6.6, energy intensity was found to be significant in very few models and negatively affecting emissions intensity. Since this relationship is found to be significant in very few models so it is not of much importance.

The variable age is found to be significant in dataset 2 and negatively related with emission intensity implying older firms to be investing in emission reducing technologies and hence emitting less. Other significant results are labor intensity found to be directly related with emission intensity implying more labor usage means more emissions, this may be due to redundant labor use in firms. One more significant result is size to be negatively related to emissions intensity implying as size of the firm, its sales and assets increases, its emissions will reduce.

Chapter 7

CONCLUSION AND RECOMMENDATION

7.0 Introduction

This chapter is a summary of the entire study, and describes our major findings, including the policy implications, the limitations of study and the perspectives of this area of research.

Following were the objectives of our study:

i) To study the energy intensity of energy intensive industries during pre and post policy intervention period

ii) To study the impact of energy cost and policy intervention on profitability and productivity of selected industries

iii) To study the emission intensity of selected industries during pre and post policy intervention period

The statistical tool selected for this study was Multiple Regression Analysis with Dummy variable. This was done on the basis of the past studies which includes such kind of research/objectives and was also found to be the most appropriate.

The methodology uses panel data modelling with various independent variables affecting the energy intensity, profitability, production and emission intensity of the industries.

On the basis of this methodology, the outputs correspond to estimations of the respective effects.

7.1 Major Findings

The corresponding findings for the objectives described above, are as follows:

7.1.1 Estimation of Energy Intensity in Energy-Intensive Industries in India

The study found that profits margin intensity is found to be significant variable affecting energy intensity of energy-intensive industries for both the datasets. As this is the basis of our study this result is of utmost importance. Energy cost forms a major proportion of total production cost in these energy-intensive industries. The same is also very much highlighted by our results. We found a significant negative relation between energy intensity (energy cost) and profit margin intensity (profits) implying as the company earns more profits its energy intensity/cost will decline implying more profitable firms invest more in energy efficiency. No definite relationship with age of the firm has been found.

The variable size of the firm was found to be significantly and negatively related to energy intensity of firms, which implies that a firm which is bigger in terms of sales and assets, will invest more in energy efficient technologies and thus reducing its energy consumption.

The variable technology import intensity was found to be significantly and negatively related to energy intensity implying that firms importing technical know-how, equipments from abroad will be more energy efficient.

PAT doesn't seem to have affected the overall performance of industries much, in some models the relationship with energy intensity was found to be negative and significant like in dataset 2. Also, for the same dataset technology imports were found to be negatively and significantly related to energy intensity of firms thereby reducing energy intensity. So this might be the reason behind decline in energy or bigger size of the firm or more profits be the reason. As far as the ECA is concerned, it was found that its creation favorably affected the energy intensity, reducing it.

7.1.2 Impact of Energy Cost and Policy Intervention on Profitability and Production of Industries

7.1.2.1 Impact of Energy Cost and Policy intervention on Profitability of industries

In this study, energy intensity is found to be significant variable affecting profit margin intensity of energy-intensive industries for both the datasets. As this is the basis of our study this result is of utmost importance. Energy cost forms a major proportion of total production cost in these energy-intensive industries. The same is also very much highlighted by our results. We found a significant negative relation between energy intensity (energy cost) and profit margin intensity (profits) implying as the company energy intensity/cost will decline it will earn more profits and hence will be more competitive in the market.

PAT is found to be significant and negatively related to profit margin intensity implying due to implementation of PAT mechanism profits of the firms have declined. This result is not in line with our expectation.

Initially we found that PAT is adversely related to profit margin intensity. This was a bit contradictory result but it may be interpreted in the sense that companies are making huge investments in advancement of technology for meeting PAT targets and gaining energy efficiency in the beginning which can be detrimental to profits margin initially but in the long run it may be beneficial to the companies increasing their profitability and hence competitiveness in the market.

Whereas in case of ECA, it is found to be favorably affecting profit margin intensity, increasing it and highly significant.

7.1.2.2 *Impact of Energy Cost and Policy intervention on Production of industries*

Our study observed that the energy consumption variable is positively related with the magnitude of the production which is also found significant in our test. In this respect, this is an obvious output, as any increase in production generates a corresponding increase in the energy consumption. Also, energy is used as an input in the production process.

Profit is also positively related with production, which is another expected output. That is, if any company earns more profit by the production of any commodity, then it will increase production in order to get more and more profit. In other way, more production leads to more profit.

It was also found that investing in technology imports is positively and significantly related to production level, implying that importing more technology is beneficial to the company and increases its production level. Unfortunately, it was not possible to ascertain the impact of PAT and ECA on the production on the outputs, as there was not a definite result.

7.1.3 Estimation of Emissions Intensity in Energy-intensive Industries in India

This study also investigated that energy intensity variable was found to be significant in very few models and negatively affecting the emissions intensity. So, as this relationship is found to be significant in very few models, it is not of much importance.

The variable age is found to be significant in dataset 2 and negatively related with emission intensity, thus suggesting that older firms are investing in emission reducing technologies and hence emitting less. Other significant results are labor intensity, which results positively related with emission intensity, implying that more labor usage means more emissions, which can be attributed to the use of redundant labor in these firms. One more significant result is that the size of the company is negatively related to emissions intensity, thus suggesting that as the size of a firm is bigger, its sales and assets also become bigger, the emissions will thus decrease.

The major findings of our study are highlighted below:

PAT doesn't seem to be significant in reducing energy intensity, there might be other factors like technology imports which might have led to decline in such energy intensity.

Also, the size of the firm in terms of sales and total assets is found to be negatively related to energy intensity, which suggests that the larger firms are investing more in energy efficiency so this could also be the reason for the decline in energy intensity in some industries.

The results indicate that ECA was effective in reducing energy intensity. In this respect, the increased energy prices could also be the reason for firms to invest more in energy efficiency practices.

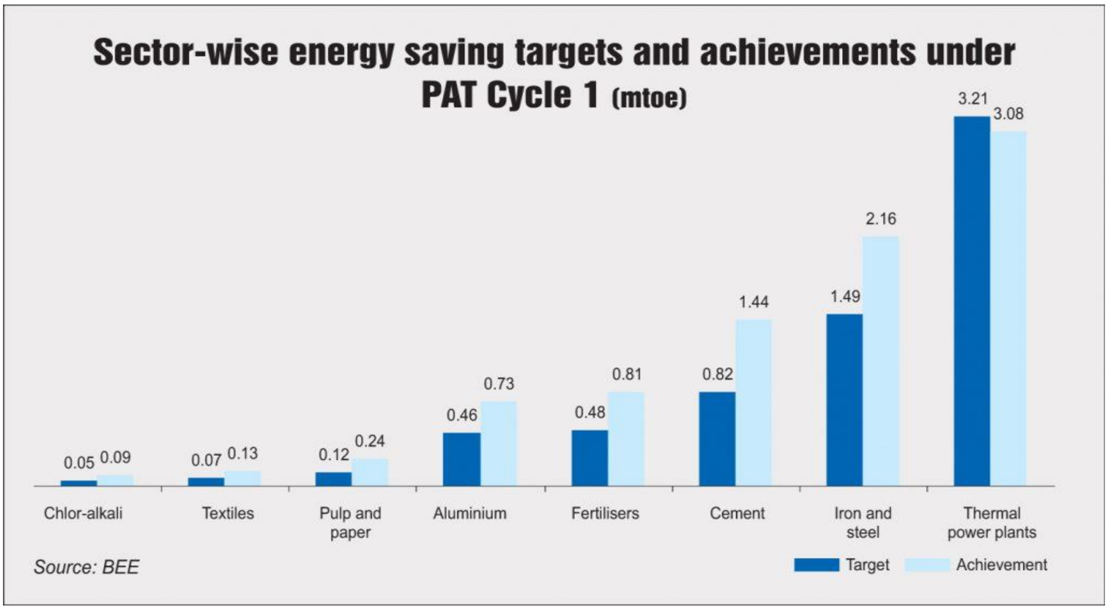
From the perspective of analyzing our business problem, the results support that energy price adversely affects the profits of the firm. On the other hand, increased profits are the result of improving the energy efficiency of the industries.

The PAT and ECA seem to have reduced the emission intensity of the firms, in particular in the case of the Aluminium, Chlor-Alkali, and Textile sectors. On the other hand, larger firms invested more in energy efficiency and hence also reduced their emissions.

PAT is an important program launched by BEE, Government of India in April 2012 under NMEEE. The scheme targeted energy efficiency in energy-intensive industries in India by means of a market based mechanism by transforming energy savings into a tradable white certificate.

As per Government records, BEE, PAT first cycle (2012-15) has been successful leading to significant reduction in energy consumption. The first cycle results showed that the industrial units covered under PAT have together succeeded their target by around 30 percent with total energy savings of about 8.67 mtoe. These 478 units covered under PAT accounts for around two percent of total commercial energy consumption in India. Also it has contributed to emission reduction by around 35 percent more than the targeted emission reduction.

First cycle of PAT started in 2012 and continued till March 2015 in which 478 firms over 8 sectors like Aluminium, Chlor-alkali, Fertilizer, Cement Thermal power and textiles, Iron and steel and Paper and pulp were alloted targets to achieve energy savings. Approximately, 75 % of the industries overachieved the energy saving targets which led to savings of around Rs. 9500 crores in monetary values.



A total investment of Rs. 261 billion is made in PAT Cycle-I for implementing energy efficiency measures. Investment made by private sector was the highest around 52 percent. The maximum investment were made by fertilizer sector and iron and steel sector 33 percent and 24 percent respectively.

The only sector which under achieve its targets is thermal power generation plants though it is the highest contributor to overall target achieved. It contributed to nearly 35 percent of the overall target achieved by all sectors. It falls short of its target by 5 percent only (3.06 mtoe against the target of 3.06 mtoe).

Under the PAT Cycle-I maximum targets achieved by the sectors are paper and pulp (143%), Cement (81.6%), Textiles (95%), Chlor-alkali(72%), Fertilizer (64%), Aluminium(60%) and Iron and Steel (41%).

Investments under PAT Cycle 1

Sector	Total no. of DCs	Investment (Rs billion)
Aluminium	9	0.95
Cement	65	25.68
Chlor Alkali	15	3.94
Fertiliser	24	87.33
Iron and Steel	37	61.75
Pulp and Paper	17	18.84
Textile	64	29.86
Thermal Power Plants	70	32.65

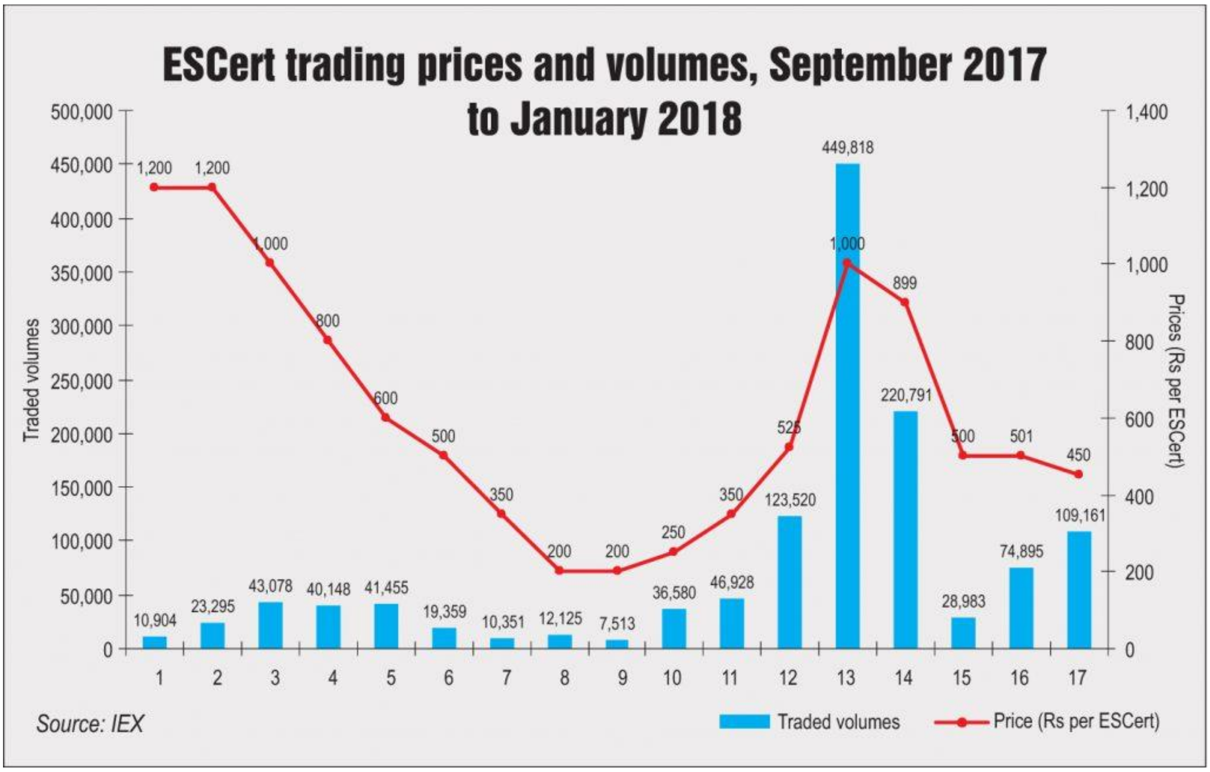
Note: Investment details were furnished by only 301 DCs

Source: BEE

Though PAT Cycle 1 seems to be successful as per Government records but there are a lot of amendments need to be made in the scheme to make it cause real time energy efficiency in Indian industries.

There were some anomalies such as changes in power mix, fuel mix, market demand and unforeseen shutdown in the data were found during the monitoring and verification stage which has also led to oversupply of ESCerts (energy trading certificates connected to PAT) in market and therefore, PAT Cycle-I targets were easily achievable leading to energy savings more than the target set. The PAT Cycle-I targets are not strict enough to lead energy efficiency beyond business-as-usual and therefore not lead to any long-term investment. PAT market may not form means there might not be any transactions of sale and purchase of ESCerts due to lack of market participants, oversupply of ESCerts.

Also, absence of any floor price for ESCerts worsen the situation as certificates were sold at as low as Rs. 200 to Rs. 1200 per certificate where it was supposed to sold at a price of atleast Rs. 10,000 per certificate. Due to this, defaulter designated consumers easily fulfilled their targets by purchasing low priced ESCerts and it seemed that it is a better and cheaper option to fulfill targets by purchasing ESCerts rather than investing in expensive energy efficient technologies (Rs. 100 crores against Rs. 24517 crores of investment).



Though PAT is a promising scheme but less penalty and low targets are major hindrance in making this scheme fruitful. Over achievement of targets in first cycle is mainly because of low targets given.

Hence, a lot of amendments needs to be done in PAT further cycles at both policy formation and implementation level, also stricter norms need to be set to bring about real change in industrial energy intensity and for it to be called an effective policy measure in India. It is also too early to judge its effectiveness as only its first cycle, 2012-15 has ended, not a very old policy measure in India.

As PAT Cycle-I is the main policy initiative forming the basis of our study therefore, our policy implications for this study also focused on PAT only. Following are the suggested policy implications:

Policy Implications of the Study:

(i) The target for PAT Cycle-I (2012-15) are easily achievable, an observation in our study. Therefore, it is highly advisable to revise the targets and make them more realistic as this is also one reason behind the overachievement of targets in PAT Cycle-I.

(ii) PAT Cycle-I (2012-15) also doesn't promise any long term investment in energy efficiency practices due to lack of clear and consistent goals. A more clear understanding of the energy sector is required, industry specific characteristics. The rules and regulations needs to be made more stringent in order to build investor's confidence in the policy.

(iii) The penalty amount for not fulfilling the set targets are also low to incentivize investment in energy efficiency practices. Designated Consumers find it more convenient to purchase ESCerts in the market rather than investing huge amount of money in energy efficiency practices. Therefore, there is urgent need to revise the penalty amount in further cycles of PAT Mechanism to cause real time investment in energy efficiency practices which is the actual aim of this mechanism.

(iv) Also, the trading of ESCerts started a bit late for PAT Cycle-I, and over supply of ESCerts due to over achievement of targets caused difficulty in market formation for PAT due to less demand for ESCerts. There was confusion about trading of ESCerts will happen or not after end of Cycle-I. Therefore, there is need to strengthen rules and regulations for the scheme and make it more cost effective.

(v) The main drawback of PAT is no floor price fixed for ESCerts. Therefore, the price of ESCerts range from as low as Rs. 200 to Rs. 1200 per certificate where it was supposed to sold at a price of atleast Rs. 10,000 per certificate. Due to this, defaulter designated consumers easily fulfilled their targets by purchasing low priced ESCerts and it seemed that it is a better and cheaper option to fulfill targets by purchasing ESCerts rather than investing in expensive energy efficient technologies (Rs. 100 crores against Rs. 24517 crores of investment). This has worsen the situation and hence there is an urgent need to set a floor price for ESCerts for future cycles to make this policy meet the desired goals.

(vi) Some anomalies in the data were found during the monitoring and verification stage which has also led to oversupply of ESCerts in market and therefore, PAT Cycle-I targets were easily achievable leading to energy savings more than the target set. So, these are some equity concerns which needs to be tackled. A very strict and clear guidelines should be prepared for target setting, auditing, variability calculation procedure and assessments in terms of site specific characteristics means efficiency in production and goods quality by the regulating or auditing agencies.

(vii) Since India is engaging a lot in climate change commitments these days, energy efficiency has a major role to play. However, there are some issues like overachievement of targets under Cycle-I due to low target setting, less penalty amount for industries that fail to meet their target and enforcement mechanism of this policy mechanism. Also, market formation for ESCerts and greater awareness needed for Designated Consumers among others. Though it is early to judge PAT success but PAT as a policy has altered energy efficiency landscape with industries taking measures to reduce their energy intensity to align their productivity goals with these programmes.

Sector wise Policy Recommendation:

Iron and steel sector

ECA seems to be successful in reducing the energy intensity of the steel sector. But PAT doesn’t seems to be much successful empirically. Profits of the firm seems to have a desirable impact on energy intensity, reducing it.

The main challenges in iron and steel sector are high energy cost, intermittent power supply, low labor productivity, obsolete technology, poor quality of raw material namely coking coal which is expensive and limited in quantity, alumina iron ore etc.

Though energy consumption by iron and steel sector has been gradually reducing but there is a long way to go. Continuous up gradation of technology and use of energy efficient technology is required to reduce production costs, carbon footprint and increase competitiveness.

Fertilizer sector

Decontrol will make the industry competitive and bring innovations in production and products. So, apart from fiscal reasons, there are solid environmental reasons to decontrol the urea sector. This is the key outlook emerging from GRP.

Textile sector

Obsolete technology and low productivity of labor has always remained a hindrance in development of this sector. High power cost and intermittent power supply is again a major problem. All these issues needs to be dealt with in order to make this sector more competitive.

Cement Sector

Though the Indian cement sector is one of the most energy efficient in the world, but still a lot more modifications and up gradation in technology is required for further enhancing energy efficiency. Also, being energy-intensive, finding alternative sources of energy such as fly ash, jatropha to substitute coal fully or partially in cement production is required.

Aluminium Sector

The main challenge with the aluminium sector is the high production costs, mainly high power costs. Despite of huge bauxite reserves, this sector still lacks competitiveness due to poor mining policy and transport infrastructure in the country. If these problems are overcome then dependency on aluminium imports can be reduced to a large extent.

Chlor-Alkali Sector

Again, with this sector also the main challenge is the high power costs of the production process and import dependency. If these problems are overcome with advancement of technology, this will make this sector more competitive.

Pulp and Paper Sector

The major problems with the pulp and paper sector is the obsolete technology, high production costs due to high power costs, raw materials, low productivity of labor, lack of good quality fibre, uneconomical plant size. Therefore, focussing on technology up gradation and investing in energy efficiency practices will be fruitful for this sector.

Thermal Power Plants

The twin problem which is faced by thermal power plants in India is their low generation capacity and high emission levels. Our country is mainly dependent on coal-fired thermal power plants to fulfil its electricity demand. And Indian coal is low quality with high ash content leading to energy inefficiency in this sector. Obsolete technology is also a problem. Therefore, around 30 percent coal used for electricity generation needs to be imported from Indonesia. If technology up gradation is done, then energy consumption in this sector could be reduced to a large extent along with decline in emission levels.

7.2 Limitations of the study

Our study is based only on selected companies/firms included under Perform, Achieve and Trade Cycle-I (2012-15) and for which data is available through CMIE Prowess Database as our study deals with studying the impact of both Perform, Achieve and Trade Cycle-I and Energy Conservation Act on the performance of energy-intensive industries in India. Other limitations of this thesis are as follows:

- The time period for our study is small, 21 years (1995-2015) data have been used. As the focus of our study is mainly to study the impact of PAT Cycle-I which ran from only 2012-15.
- We have adopted a working definition for production, used sales as a proxy as in many other studies due to unavailability of desirable data.
- Firm level/ Company level data used due to unavailability of plant level data on CMIE ProwessIQ database.
- Only those companies are included in the study which are covered under PAT as the focus of our study is to see the impact of PAT Cycle-I on energy intensity of industries.
- For Thermal Power Plants, due to unavailability of plant data, data for power generating companies owning that power plant has been used.

- Emission factors for UK has been used to calculate firm level emissions due to the kind of data available on CMIE ProwessIQ.

7.3 Scope for future research

The same research may be undertaken for further cycles of PAT combined or individually. Also, this research can be taken for all the eight sectors included in PAT Cycle-I individually. The research can be undertaken by including more independent variables and then finding out appropriate results. Also, impact on performance of industries can be studied accounting for other policy measures as well.

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ANNEXURE

Annexure 2.1: Literature Review in Tabular form

The literature survey has been summarized in the following table, based on the themes

Identification of variables affecting (i) Profitability of firms (ii) Emission intensity of firms (iii) Energy intensity of firms.

Dependent Variable	Independent Variable	Author	Inference/Findings
Profitability	energy intensity	Cantore, Nicola; Calì, Massimiliano (2011); Sahu, Narayan (2014);	A positive relation of profitability with energy intensity has been found. For manufacturing industries, more energy efficient the industry more profitable it is, in most of the developing countries.
	labor intensity (manpower cost)	Cantore, Nicola; Calì, Massimiliano (2011)	Labor intensity is positively related to profitability
	raw materials cost (excluding fuels)	Cantore, Nicola; Calì, Massimiliano (2011)	Raw materials cost (excluding fuels) is negatively related to profitability
	Number of workers	Cantore, Nicola; Calì, Massimiliano (2011)	Number of workers employed also affects profitability
	Capital intensity	Cantore, Nicola; Calì, Massimiliano (2011), S.K. Sahu (2014)	Domestic firms using natural gas as primary source of energy are more capital-intensive in comparison to firms using coal and oil.

	Industry (dummy variable)	Cantore, Nicola; Calì, Massimiliano (2011)	When we add certain controls at firm-level such as age, number of workers, accounting for exporter and foreign ownership in the form of dummy variable, we found industry dummy does not affect profitability.
	Exporting firm (dummy variable)	Cantore, Nicola; Calì, Massimiliano (2011)	When we add certain firm-level controls, we found profitability is not affected by exporting firm.
	Foreign owned (dummy variable) (foreign or domestic)	Cantore, Nicola; Calì, Massimiliano (2011)	When we add certain firm-level controls, we found profitability is not affected by foreign-owned firm.
	ISO9000 certification (dummy variable)	Cantore, Nicola; Calì, Massimiliano (2011)	When we add certain firm-level controls, we found profitability is not affected by ISO9000 certification of the firm.
	Firm size (natural log of net sales)	S.K. Sahu (2014); Al-Jafari, Mohamed Khaled; Samman, Hazem Al (2015), Amirhassan Alahyari (2014); N.Sivathaasan,	Size of the firm is nonlinearly related to profitability. Size of the firm is positively related to profitability. Also been emphasized by various studies that size is an important variable

		R.Tharanika, M.Sinthuja, V.Hanitha (2013); Dharmendra S. Mistry (2012)	affecting profitability.
	R and D intensity	S.K. Sahu (2014)	R&D intensity is found to be positively related to profitability. Firms using coal as primary source of energy are more profitable by being less R&D intensive.
	Age of the firm	S.K. Sahu (2014); Bhayani, Sanjay J. (2010)	Profitability is positively related to age of the firm.
	MNE Affiliation (dummy variable : foreign or domestic)	S.K. Sahu (2014)	The profitability of MNE affiliated firms those using coal as primary source is high in comparison to firms using petroleum and natural gas. Capital intensity of the MNE affiliated firms that use natural gas is higher in comparison to firms using petroleum and natural gas. Energy intensity and R&D intensity is least for firms using natural gas and highest for firms using

			coal. Same results for domestic firms also.
	Choice of fuel	S.K. Sahu (2014)	Based on whether the firm used coal or petroleum or natural gas as primary source of energy, their results with respect to profitabiliy can vary.

Dependent Variable	Independent Variable	Author	Inference
Emission Intensity/Carbon -dioxide emissions	capital intensity	Sahu, Narayan (2013); Sahu, Narayan (2012); Marta Nowogorska (2013); Subodh Kumar, Munesh Lal Meena (2017)	Emissions by a firm is positively related to capital intensity.
	labour intensity	Sahu, Narayan (2013); Sahu, Narayan (2012); Subodh Kumar, Munesh Lal Meena (2017)	The variable of labour intensity is found to indirectly affecting emission intensity and is significant at 1% level of significance.

	energy intensity	Sahu, Narayan (2013); Sahu, Narayan (2012); Yeonbae Kim, Ernst Worrell (2002); Marta Nowogorska (2013); Subodh Kumar, Munesh Lal Meena (2017)	The relation between energy intensity and emission intensity is found to be significant and positive.
	firm size	Sahu, Narayan (2013); Hena Oak (2017); Sahu, Narayan (2012); Marta Nowogorska (2013); Subodh Kumar, Munesh Lal Meena (2017)	A negative relation is found between size of the firm and emission intensity with statistical significance.
	Age of the firm	Sahu, Narayan (2013); Hena Oak (2017); Sahu, Narayan (2012); Marta Nowogorska (2013); Subodh Kumar, Munesh Lal Meena (2017)	There is a positive relation between Age of the firm and emission intensity.
	technology import intensity	Sahu, Narayan (2013); Hena Oak (2017); Sahu, Narayan (2012); Subodh Kumar, Munesh Lal Meena (2017)	A positive relation is found between technology import intensity and emission intensity.
	research and	Sahu, Narayan	A positive relation is

	development intensity	(2013); Sahu, Narayan (2012);	found between R&D intensity and emission intensity.
	multinational affiliation	Sahu, Narayan (2013); Sahu, Narayan (2012);	MNE affiliation of firms is not statistically significant. Foreign firms are investing more in R&D and technology import and also better in terms of emissions than domestic firms.
	Regulatory intervention	Doonan et. al. (2005); Marta Nowogorska (2013)	A major factor affecting environmental performance is regulatory intervention.
	Production/output	Yeonbae Kim, Ernst Worrell (2002); Marta Nowogorska(2013)	Changes in production level is also a factor affecting CO2 emissions.
	Fuel-mix/choice of fuel	Marta Nowogorska (2013)	Fuel-mix determines the amount of pollution emitted.

Dependent Variable	Independent Variable	Author	Inference
Energy Intensity	Firm size	Sahu, Narayan (2009, 2011); Bishwanath Goldar (2010); Kumar (2003); Hena Oak (2017); Papadogonas et. al. (2007); Oczkowski and Sharma (2005); Faruq and Yi (2010)	The relationship between firm size and energy intensity is non-linear (U shape) means both very small and very large firms have high energy intensity in relation to medium-sized firms. The coefficient representing firm size is negative and significant, the coefficient representing square of firm size is positive and significant. For energy-intensive industries, firms of large size are not energy efficient. The relation between firm size and energy consumption is not very obvious as stated by some authors. Negative relationship was found by Kumar (2003) and Goldar (2010), though Sahu and Narayanan (2009) first found an inverted U relationship in cross sectional study in 2008, and then eventually a U shaped relationship between the two variables using a pooled of cross-section data for 9 years (Sahu and Narayanan, 2010). Large firms can benefit from economies of scale due to diminishing returns in the use of

			energy, but this effect is not strongly identified by Sahu and Narayan and Kumar. But as per Papadogonas et. al. (2007), firms with large size have energy cost advantage than low energy consuming industries.
	Age of the firm	Sahu, Narayan (2009, 2011); Bishwanath Goldar (2010); Kumar (2003); Hena Oak (2017); Papadogonas et. al. (2007)	Many authors found energy efficiency of industries increases with their age. Young firms are found to be energy efficient in comparison to old vintage firms. Age coefficient is positive and significant and the coefficient representing square of the age of the firm is significant and negative. Therefore, an inverted U shape relationship is found between energy intensity and firm's age.
	Export intensity	Sahu, Narayan (2009, 2011)	Not much significant effect
	Import of finished goods intensity	Sahu, Narayan (2009, 2011); Bishwanath Goldar (2010)	Captured by technology it is considered to be an important determinant.
	Raw materials import intensity	Sahu, Narayan (2009, 2011); Bishwanath Goldar (2010)	It is considered to be a determinant.
	Capital goods intensity	Sahu, Narayan (2009, 2011); Hena Oak (2017);	Capital intensive firms are more energy intensive.

		Morikawa (2012)	
	Technology import intensity	Sahu, Narayan (2009, 2011); Bishwanath Goldar (2010); Kumar (2003); Kumar (1987); Hena Oak (2017)	Imports of technology is an important determinant to decline in firm level energy intensity and it is represented by capital. Spillover effects from foreign firms to Indian firms can be seen for technology energy efficiency.
	R&D Intensity/Expenditure/ Dummy	Sahu, Narayan (2009,2011); Vanden, and Quan (2002); Bishwanath Goldar (2010); Kumar (2003); Kumar (1987); Vanden et. al. (2004); Papadogonas et. al. (2007)	More the Research and Development intensity, more the energy intensity. R&D expenditure reduces energy intensity of firms. Captured by technology it is an important determinant. But in contradiction to this, R and D investment intensity is not found to be related to less energy intensity (Kumar, 2003; Sahu and Narayanan 2009) and even turned out to be positively correlated (Sahu and Narayanan, 2010). But using R and D dummy, Goldar (2010) obtained the negative effect on energy intensity as expected. In addition to this, according to Papadogonas et. al. (2007), energy intensity of high technology industries is less.

	IT use intensity	Sahu, Narayan (2009, 2011); Bishwanath Goldar (2010)	Use of IT help in improving energy use efficiency.
	Advertisement intensity	Sahu, Narayan (2009, 2011); Bishwanath Goldar (2010)	Coefficient of advertisement intensity is statistically significant and negative. This variable is stating technological differences among industries. Negative coefficient is a sign that ceteris paribus, energy intensity is lower in consumer goods industries particularly consumer durables.
	Repairs intensity	Sahu, Narayan (2009, 2011); Kumar (2003); Papadogonas et. al. (2007); Bishwanath Goldar (2010)	Firms spending more on repairs and capital intensive firms are more energy intensive. Positive relation is found between repair intensity and energy intensity.
	Foreign firm (Dummy Variable)	Sahu, Narayan (2009, 2010, 2011); Bishwanath Goldar (2010); Kumar (2003)	In comparison to domestic firms, foreign-owned firms are lesser energy-intensive. Foreign firms are less energy intensive in Kumar (2003), Sahu and Narayanan (2009) and Goldar (2010) but not in Sahu and Narayanan (2010). Effect of foreign ownership on energy consumption/intensity is not very obvious. It depends on country's environmental regulations and energy prices.

			Also, it is fruitful to look at the impact of ownership structure on energy efficiency, because differences may appear due to private and public ownership.
	Output-capital ratio	Sahu, Narayan (2009, 2011); Bishwanath Goldar (2010)	A negative relation was found between energy intensity and capital-output ratio.
	Labor intensity	Sahu, Narayan (2009, 2011); Subrahmanya (2006); Dargay et. al (1983); Lachaal et. al (2005); Morikawa (2012)	Coefficient of labour intensity was found to be insignificant. That means labour intensity does not seem to be affecting the energy intensity of the firms. As there is a negative relationship found it can be assumed that high labour intensive firms are using more energy saving techniques compared to the low labour intensive firms. The results show that energy demand is negatively related to hike in energy prices and positively to a hike in real wages.
	Capital intensity	Sahu, Narayan (2009, 2011); Dargay et. al (1983); Kumar (2003); Hena Oak (2017); Bishwanath Goldar (2010);	Capital intensive firms as well as firms spending more on repair and maintenance are found to be more energy intensive

		Papadogonas et. al. (2007); A.Miketa (2001)	
	Research intensity	Sahu, Narayan (2009, 2011)	Research is captured by R&D variable.
	Profit margin	Sahu, Narayan (2009, 2011); Kumar (2003)	A positive relationship is found between profit margin and energy intensity but the result is not statistically significant
	Firm dummy	Sahu, Narayan (2009, 2011)	It is also an important variable.
	Industry dummy/MNE Affiliation	Sahu, Narayan (2009, 2011); Kumar (2003)	MNE affiliated firms are less energy intensive
	Energy prices/Energy price elasticity/Wages	Vanden, and Quan (2002); Andersen et al. (1998); Thomsen (2000); Dargay et. al (1983); Greening et al. (1998); Kumar (2003); Schurr (1982); Jorgenson (1984); Vanden et. al (2004); Gupta, Manish; Sengupta, Ramprasad (2011); A. Miketa (2001)	For Chinese firms relative energy prices are affecting energy intensity. Energy price elasticity for various industrial sub-sectors ranges between -0.10 and -0.35, particularly for manufacturing sector it turned out to be -0.26. Also for Swedish Manufacturing industries relative changes in energy prices affects energy consumption/intensity. In case of India, there is a significant response of energy consumption to own price increases and to the insignificance of capital requirement responsiveness to energy conservation. Major part of the growth of factor

			productivity has been found to be induced by changes in energy prices, price neutral component of technical change being negligible.

Apart from this, themes includes: (iv) Emission intensity in industries (v) Indian Scenario Industrial Energy Efficiency/ Energy intensity in industries (vi) Industrial Energy Efficiency relation with profitability (vii) Industrial Energy Efficiency relation with productivity

THEME	AUTHORS	FINDINGS	Gaps
(iv) Emission intensity in Industries	Fallis, A.G (2013); Patterson (1996); Subrahmanya, M. H B (2006); Vine, Edward (2005); Ranjan, R. (2015); Schleich, Joachim et al. (2009); Kim, Yeonbae ;Worrell, Ernst (2002); Srinivasan, P et al. (2015); Paul , ,Bhattacharya (2004); Morrow, William R.; Sathaye, Jayant et al. (2014); IEA (2007); Chen,	As highlighted by many authors, emission reduction is a benefit attached to energy efficiency in industries. The improvement in energy efficiency leads to decline in greenhouse gases such as SO_X, NO_X and CO_2 etc. As per IEA (2007), improvement in energy efficiency will lead to benefit of energy security, industry competitiveness and environmental benefits such as reduction in CO_2. Countries are under tremendous pressure to clean pollution from industry and limits its growth.	Emission reduction linkage with energy intensity of industries Impact of policy intervention in industries on emission intensity of these industries

	Liang et al. (2013); Goldar, Bishwanath (2013); Kumar, Subodh (2017); Sahu, Santosh Kumar; Narayanan, K (2013); Yassine, Ghouali et al. (2015); Marta Nowogorska et al. (2013);	As per Business Line article dated December 6, 2018, the fourth highest emitter of carbon-dioxide in the world is India after China, US and European Union. It accounts for 7% of global emissions in 2017. Industries contribute around one fourth of India's total GHG emissions. Industrial Emissions Grew 8.89 Percent Annually from 2005-2013 (Gupta and Biswas, 2017). An increase in energy intensity leads higher emission intensity. Also, higher emission intensive industries are capital intensive and less emission intensive industries are labour-intensive. This leads to a question regarding use of technology in manufacturing industries particularly high emission intensive. Indian manufacturing sector doesn't support Environmental Kuznets Curve (Ranjan, 2015). A long run relationship exists between energy consumption, CO_2 emissions, economic	

		activity and trade. Empirical results confirm that energy consumption drives economic activity in short run. More energy demand is associated with economic growth. Also, in short run one way causation exists between energy consumption to CO_2 emissions and trade and CO_2 emissions to economic growth (Srinivasan, 2014). Kim and Worrell (2002) carried out the decomposition analysis to study the trend of CO2 emissions in iron and steel industry in seven countries including both developed and industrialized countries like United States and developing countries like India, Brazil etc. They found development in energy intensity is linked to technology change and indirectly to policy. Energy efficiency was found to be the most important factor behind decline in energy intensity in all countries and also increased or decreased production level affects	

		emission intensities in most of the countries. As per a study, from 2010 to 2030 for cement industry electricity savings and associated emissions reduction are 83 TWh and 82 Mt CO_2 respectively. Also, fuel savings and associated emissions reduction are 1029 PJ and 97 Mt CO_2 respectively. In Indian steel sector, from 2010 to 2030, electricity savings and associated emissions reduction are 66 TWh and 65 Mt CO_2 respectively. Also, fuel savings and associated emissions reduction are 768 PJ and 67 Mt CO_2 respectively. (Morrow et al., 2013). There are variation in firm-level emission intensity due to difference in firm specific characteristics such as size, age, energy intensity Also, technology intensity is found to be a determinant of CO_2 emission of Indian manufacturing firms and capital and labour intensity of the firms also affects firms'	

		CO2 emission intensity (Kumar and Meena, 2017). Inter-firm energy and emission intensity differences are also found by Sahu and Mehta, 2015 in their study. They also found out that more energy intensive industries are also emission intensive. Also, both small and large firms are energy and emission intensive as compared to medium sized firms. India requires double the amount of energy to produce same level of output as China. Iron and steel and non-metallic minerals sector represents highest level of energy intensity in India (Pappas and Chalvatiz, 2016).	

(v) Indian Scenario Industrial Energy Efficiency/ Energy intensity in industries	Vasudevan, Cherail, Bhatia, Jayaram (2011); IEA (2015); Ray (2011); Gielen,Taylor (2009); Mukherjee (2008); Phylipsen (2011); Dutta, Mukherjee (2010); IEA (2011), Mukherjee, Kankana(2010); Compton, Mallory; UNIDO (2011); UNEP (2006); Reddy, Amulya K.N.; (1991);	Energy intensity by Indian industries is high. There are few prominent types of Industries which are highly energy-intensive such as Iron and Steel, Fertilizer, Cement, Textiles, Chlor-Alkali, Aluminium, Pulp and Paper etc and termed as Designated Consumers (DCs) under EC Act, 2001. In these industries, energy intensities are above the average energy intensity of all manufacturing industries in India. Also, energy intensity varies over time as well as over type of	Functional form of K.L.EM production function Use of Energy as input in Cobb-Douglas production function Correct and realistic assessment of Energy Efficiency
(vi) Industrial Energy Efficiency relation with Profitability	Sahu (2014); Sahu, Narayan (2011); Goldar (2010); Calì, Cantore (2010); Sahu (2009); Reddy, Ray (2010);Compton (UNIDO) (2011); Eichhammer and Walz (UNIDO) (2011); Narayan, Sahu (2010);	Sahu and Narayan (2014) found a positive relation between energy intensity and profitability for all the manufacturing firms using coal, petroleum as their primary source of energy except firms using natural gas implying switching to natural gas as primary source of energy will increase their profitability. Higher energy efficiency is associated with higher profitability in manufacturing industry of vast majority of	Relation between energy intensity and profitability when accounting for summation of all types of energy used for production by industries Accounting energy intensity as energy consumption per unit of output/production unlike literature

		developing countries (UNIDO, 2011). IPCC has estimated that 10-30 percent of energy consumption could be reduced without an additional net costs to the company which implies energy efficiency could contribute to reduced overall company costs.	where most of the authors have accounted it as per unit of Net Sales Impact of industrial policy interventions on profitability of industries

Theme	Authors	Findings/Inference	Gaps
(vii) Energy Efficiency relation with productivity	Sahu (2011); Mongia, Sathaye (1998); Mandal, Madheswaran (2010); Sanstad, Mongia ,Schumacher (1999); Mongia, Sathaye (1998); Boyd, Pang (2000); Laitner,Finman,Worrell, Ruth (2001); Subrahmanya (2006); Sethi, Pal	According to a study by Sahu (2011), energy intensity was found to be negatively related to Total Factor Productivity (TFP). Energy efficient firms have more TFP. As per Sathaye (1998), during 1978-98, high demand for energy was moderated by their productivity growth in manufacturing industry. Increasing energy prices will have negative effect on productivity in Indian industries (Roy, 1999). A good understanding of rate and	Impact of industrial policy interventions on productivity Accounting for change in productivity of industries using Cobb-Douglas production

		direction of technological change, change in energy prices, inter-fuel substitution is required for policy implication. As per the study by Madheswaran (2010), during the period 1980-2005, energy consumption is directly related to output growth in Indian cement industry. Productivity benefits of energy efficiency improvement must be included in economic assessment of the potential of energy efficiency improvement (Worrell, 2001). In small scale industries in India, link of energy intensity to productivity and profitability is prominent (Pal, 2006).	form

Annexure 4.1: Regression results to study the impact on energy intensity of industries pre and post policy intervention

Table I : Regression results indicating impact on energy intensity (Lnei) taking Both PAT and ECA together for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**
	Pooled OLS (Lnei) Robust	**Fixed Effect (Lnei) Robust**	**Random Effect (Lnei) Robust**	**Pooled OLS i.panelid (Lnei)**	**Pooled OLS i.industryid (Lnei)**	**GLS i.panelid (Lnei)**	**GLS i.industryid (Lnei)**
Lnpmi	-.1383749*** (.0333082)	-.0963204* (.055059)	-.0968724* (.0541319)	-.0963204*** (.0230025)	-.1579287*** (.0270694)	-.0963204*** (.022253)	-.1579287*** (.0267702)
Lna	-.0364682*** (.0071731)	.0226978 (.0612144)	.0044336* (.0387638)	.0226978 (.0238962)	.0121873* (.0089333)	.0226978 (.0231176)	.0121873* (.0088346)
Lnli	.5432704*** (.11062)	.3098308** (.1492462)	.3178417** (.1523677)	.3098308*** (.0825247)	.3675838*** (.0904738)	.3098308*** (.0798359)	.3675838*** (.089474)
Lnci	.0677819*** (.0204687)	.0445515 (.0626074)	.045651 (.0623959)	.0445515*** (.0128156)	.03988*** (.0152257)	.0445515*** (.0123981)	.03988*** (.0150575)
Lnri	.9670978*** (.3273975)	.2318607 (.7929765)	.2825343 (.7281109)	.2318607 (.37542)	.0545491 (.303354)	.2318607 (.3631881)	.0545491 (.3000019)
Lnsi	-.0170644*** (.0033084)	-.0115348 (.0116209)	-.0110379 (.0091148)	-.0115348** (.0054122)	-.0237107** (.0026763)	-.0115348** (.0052359)	-.0237107*** (.0026467)
Lntmi	-.0493375 (.0367126)	-.0747892* (.0433053)	-.0757695* (.0432483)	-.0747892*** (.0212312)	-.0875044*** (.024584)	-.0747892*** (.0205395)	-.0875044*** (.0243124)
_cons	.3985478*** (.0531133)	.1691403 (.2436046)	.2257297 (.2073221)	.2605553*** (.0732826)	.416889*** (.0471347)	.2605553*** (.0708949)	.416889*** (.0466138)
Pat	.0242275** (.0100574)	.008617 (.0093633)	.0119401 (.0080228)	.008617 (.0072333)	.0126152* (.0089681)	.008617 (.0069976)	.0126152 (.008869)
Eca	-.0144478* (.0092642)	-.025375 (.0207722)	-.0210056 (.0189799)	-.025375*** (.0080925)	-.0183901** (.0084846)	-.025375** (.0078288)	-.0183901** (.0083908)
No. of obs.	546	546	546	546	546	546	546
No. of groups	26	26	26	26	26	26	26
F	F(9, 536) = 26.89	F(9,25) = 4.66	Wald chi2(9) = 45.82	F(34, 511) = 41.13	F(11, 534) = 38.57	Wald chi2(34) = 1494.24	Wald chi2(11) = 433.82
Prob > F	Prob > F = 0.0000	Prob > F = 0.0011	Prob > chi2 = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table II : Regression results indicating impact on energy intensity (Lnei) taking only ECA for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-IX**	**Model-X**	**Model-XI**
	Pooled OLS Lnei)	**Pooled OLS (Lnei) Robust**	**Fixed Effect (Lnei)**	**Fixed Effect (Lnei) Robust**	**Random Effect (Lnpei)**	**Random Effect (Lnei) Robust**	**Generalised Least Square (Lnei)**	**Pooled OLS i.panelid (Lnei)**	**Pooled OLS i.industryid (Lnei)**	**GLS i.panelid (Lnei)**	**GLS i.industryid (Lnei)**
Lnpmi	-.1431384*** (.0305873)	-.1431384*** (.0335208)	-.0988111*** (.0229166)	-.0988111* (.0558473)	-.0999456*** (.0227533)	-.0999456* (.0551476)	-.1431384*** (.0303342)	-.0988111*** (.0229166)	-.1604189*** (.0270361)	-.0988111*** (.0221916)	-.1604189*** (.0267624)
Lna	-.0345565*** (.0087962)	-.0345565*** (.0071049)	.0344952* (.0217565)	.0344952 (.0571878)	.015421 (.0173919)	.015421 (.0392697)	-.0345565*** (.0087234)	.0344952* (.0217565)	.0138678* (.0088612)	.0344952* (.0210682)	.0138678* (.0087714)
Lnli	.5298268*** (.1016271)	.5298268*** (.1135428)	.3046998*** (.082446)	.3046998** (.1511594)	.311049*** (.0816795)	.311049** (.1550979)	.5298268*** (1007861)	.3046998*** (.082446)	.3590179*** (.0903511)	.3046998*** (.0798377)	.3590179*** (0894364)
Lnci	.0652031*** (.0171551)	.0652031*** (.0203637)	.0431629*** (.0127678)	.0431629 (.0623562)	.043658*** (.0126867)	.043658 (.0620985)	.0652031*** (.0170131)	.0431629*** (.0127678)	.0382189** (.0151937)	.0431629*** (.0123638)	.0382189*** (.0150399)
Lnri	.9375254*** (.3223522)	.9375254*** (.3277009)	.2027609 (.3747779)	.2027609 (.7863485)	.2291181 (.3605281)	.2291181 (.7177944)	.9375254*** (.3196844)	.2027609 (.3747779)	.0339299 (.3032766)	.2027609 (.3629214)	.0339299 (.3002061)
Lnsi	-.0166117*** (.0027232)	-.0166117*** (.003299)	-.0117749** (.0054107)	-.0117749 (.0118422)	-.0106564** (.0045685)	-.0106564 (.0093258)	-.0166117*** (.0027006)	-.0117749** (.0054107)	-.0234881*** (.002674)	-.0117749** (.0052395)	-.0234881*** (.002647)
Lntmi	-.0482135* (.0273848)	-.0482135 (.0357624)	-.0728203*** (.0211755)	-.0728203* (.0430182)	-.0733205*** (.0210436)	-.0733205* (.04274)	-.0482135* (.0271582)	-.0728203*** (.0211755)	-.0876365*** (.0246063)	-.0728203*** (.0205055)	-.0876365*** (.0243572)
_cons	.3896098*** (.0428304)	.3896098*** (.0531708)	.1320419** (.0629979)	.1320419 (.2353314)	.1858615*** (.0592062)	.1858615 (.2087786)	.3896098*** (.042476)	.22369*** (.0664556)	.4107613*** (.0469759)	.22369** (.0643532)	.4107613*** (.0465003)
eca	-.0085057 (.0092623)	-.0085057 (.0091144)	-.026556*** (.0080349)	-.026556 (.0204247)	-.0213774*** (.0075322)	-.0213774 (.0190371)	-.0085057 (.0091856)	-.026556*** (.0080349)	-.015449** (.0082304)	-.026556*** (.0077807)	-.015449** (.0081471)
No. of obs.	546	546	546	546	546	546	546	546	546	546	546
No. of groups	26	26	26	26	26	26	26	26	26	26	26
F	F(8, 537) = 24.84	F(8, 537) = 29.63	F(8,512) = 10.44	F(8,25) = 4.53	Wald chi2(8) = 88.67	Wald chi2(8) = 38.28	Wald chi2(8) = 202.06	F(33, 512) = 42.30	F(10, 535) = 42.15	Wald chi2(33) = 1488.58	Wald chi2(10) = 430.20
Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0017	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table III : Regression results indicating impact on energy intensity (Lnei) taking only PAT for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-IX**	**Model-X**	**Model-XI**
	Pooled OLS (Lnei)	**Pooled OLS (Lnei) Robust**	**Fixed Effect (Lnei)**	**Fixed Effect (Lnei) Robust**	**Random Effect (Lnei)**	**Random Effect (Lnei) Robust**	**Generalised Least Square (Lnei)**	**Pooled OLS i.panelid (Lnei)**	**Pooled OLS i.industryid (Lnei)**	**GLS i.panelid (Lnei)**	**GLS i.industryid (Lnei)**
Lnpmi	-.1436128*** (.030358)	-.1436128*** (.0328519)	-.1023884*** (.0231178)	-.1023884* (.0565936)	-.1040725*** (.0227849)	-.1040725** (.0563138)	-.1436128** (.0301067)	-.1023884*** (.0231178)	-.1652002*** (.0269533)	-.1023884*** (.0223864)	-.1652002*** (.0266805)
Lna	-.0374209*** (.0087821)	-.0374209*** (.0072774)	-.0187737 (.0200733)	-.0187737 (.0620195)	-.0196359 (.0164546)	-.0196359 (.046984)	-.0374209*** (.0087094)	-.0187737 (.0200733)	.0100543 (.0089096)	-.0187737 (.0194382)	.0100543 (.0088194)
Lnli	.490934*** (.0953649)	.490934*** (.1029056)	.2218561*** (.0782755)	.2218561* (.1315744)	.233434*** (.0762804)	.233434* (.1292467)	.490934*** (.0945757)	.2218561*** (.0782755)	.3016126*** (.0854943)	.2218561*** (.0757992)	.3016126*** (.0846287)
Lnci	.0693603** (.0171027)	.0693603*** (.0201397)	.0498447*** (.0128131)	.0498447 (.0618756)	.0504789*** (.0126822)	.0504789 (.0610545)	.0693603*** (.0169612)	.0498447*** (.0128131)	.0420923*** (.0152439)	.0498447*** (.0124077)	.0420923*** (.0150895)
Lnri	.9856257*** (.3213327)	.9856257*** (.3254655)	.1568328 (.3778744)	.1568328 (8157901)	.2523143 (.3632594)	.2523143 (.741179)	.9856257*** (.3186734)	.1568328 (.3778744)	.0598939 (.3043905)	.1568328 (.36592)	.0598939 (.3013087)
Lnsi	-.0174669*** (.0027081)	-.0174669*** (.0032554)	-.0103325** (.005445)	-.0103325 (.0103854)	-.0117541** (.0045793)	-.0117541* (.0086769)	-.0174669*** (.0026857)	-.0103325** (.005445)	-.0244785*** (.0026619)	-.0103325** (.0052727)	-.0244785*** (.0026349)
Lntmi	-.0542485** (.0271077)	-.0542485* (.0344993)	-.0857941*** (.021119)	-.0857941** (.0392243)	-.0851554*** (.0209197)	-.0851554** (.0390303)	-.0542485** (.0268834)	-.0857941*** (.021119)	-.0921453*** (.0245751)	-.0857941*** (.0204508)	-.0921453*** (.0243263)
_cons	.3992077*** (.0428557)	.3992077*** (.0529691)	.2948093*** (.0581931)	.2948093 (.2664312)	.3103456*** (.0561784)	.3103456* (.2401123)	.3992077*** (.042501)	.3887809*** (.0613341)	.425663*** (.0471225)	.3887809*** (.0593938)	.425663*** (.0466454)
pat	.0202438** (.0097896)	.0202438** (.0098637)	.0113953* (.0072404)	.0113953 (.0088415)	.0125252** (.007016)	.0125252* (.0081963)	.0202438** (.0097086)	.0113953* (.0072404)	.0078252 (.0087216)	.0113953* (.0070114)	.0078252 (.0086333)
No. of obs.	546	546	546	546	546	546	546	546	546	546	546
No. of groups	26	26	26	26	26	26	26	26	26	26	26
F	F(8, 537) = 25.43	F(8, 537) = 30.93	F(8,512) = 9.23	F(8,25) = 5.57	Wald chi2(8) = 83.16	Wald chi2(8) = 50.52	Wald chi2(8) = 206.83	F(33, 512) = 41.37	F(10, 535) = 41.67	Wald chi2(33) = 1455.72	Wald chi2(10) = 425.27
Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0004	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table IV : Regression results indicating impact on energy intensity (Lnei) taking both PAT and ECA together for Dataset 2

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**
	Pooled OLS (Lnei) Robust	**Fixed Effect (Lnei) Robust**	**Random Effect (Lnei) Robust**	**Pooled OLS i.panelid (Lnei)**	**Pooled OLS i.industryid (Lnei)**	**GLS i.panelid (Lnei)**	**GLS i.industryid (Lnei)**
Lnpmi	-.1386431*** (.0279313)	-.043904** (.022164)	-.0463722** (.0222974)	-.043904*** (.0092354)	-.0931941*** (.0119451)	-.043904*** (.00898)	-.0931941*** (.0118807)
Lna	.0310971*** (.0062182)	-.0034071 (.0198766)	.0044275 (.0178578)	-.0034071 (.0092298)	-.0020589 (.0043077)	-.0034071 (.0089746)	-.0020589 (.0042845)
Lnli	-.2934836*** (.0587472)	-.0181267 (.1078649)	-.031264 (.1051846)	-.0181267 (.0508057)	-.2396885*** (.0540878)	-.0181267 (.049401)	-.2396885*** (.0537962)
Lnci	.0314999*** (.0101197)	.0007538 (.0209904)	.0020494 (.0202179)	.0007538 (.0066538)	.010231* (.0075565)	.0007538 (.0064698)	.010231* (.0075157)
Lnri	.3862165** (.1891733)	.4802578* (.274756)	.472917* (.2669046)	.4802578*** (.1393632)	.3296822** (.1439975)	.4802578*** (.1355101)	.3296822** (.1432213)
Lnsi	-.0170617*** (.0022322)	-.003875 (.0037822)	-.0057945* (.00402)	-.003875** (.0018629)	-.0036625*** (.0012845)	-.003875** (.0018114)	-.0036625*** (.0012775)
Lntmi	-.1582078*** (.0312622)	-.0393351* (.021571)	-.0433391** (.0213451)	-.0393351*** (.0129987)	-.0440935*** (.0152418)	-.0393351*** (.0126393)	-.0440935*** (.0151596)
_cons	.1896644*** (.031067)	.1681664* (.0920852)	.1613248* (.091449)	.2656603*** (.029377)	.2738655*** (.0174361)	.2656603*** (.0285648)	.2738655*** (.0173421)
Pat	-.0078574 (.006626)	-.0079381* (.0054549)	-.0086057* (.0052033)	-.0079381** (.0035868)	-.0077581* (.0050033)	-.0079381** (.0034876)	-.0077581* (.0049763)
Eca	-.0016942 (.0062456)	-.0081985* (.0060256)	-.0091237* (.0062742)	-.0081985** (.0037514)	-.0027143 (.0045714)	-.0081985** (.0036476)	-.0027143 (.0045468)
Number of obs.	1302	1302	1302	1302	1302	1302	1302
Number of groups	62	62	62	62	62	62	62
F	F(9, 1292) = 27.87	F(9,61) = 3.11	Wald chi2(9) = 32.95	F(70, 1231) = 86.33	F(13, 1288) = 141.75	Wald chi2(70) = 6391.80	Wald chi2(13) = 1862.82
Prob > F	Prob > F = 0.0000	Prob > F = 0.0038	Prob > chi2 = 0.0001	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table V : Regression results indicating impact on energy intensity (Lnei) taking only PAT for Dataset 2

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-VIII**	**Model-IX**	**Model-X**
	Pooled OLS (Lnei)	**Pooled OLS (Lnei) Robust**	**Fixed Effect (Lnei)**	**Fixed Effect (Lnei) Robust**	**Random Effect (Lnei)**	**Random Effect (Lnei) Robust**	**Generalised Least Square (Lnei)**	**Pooled OLS i.panelid (Lnei)**	**Pooled OLS i.industryid (Lnei)**	**GLS i.panelid (Lnei)**	**GLS i.industryid (Lnei)**
Lnpmi	-.1388975*** (.0146751)	-.1388975*** (.0277872)	-.0466111*** (.009166)	-.0466111** (.0220389)	-.0493699*** (.0091864)	-.0493699** (.0222833)	-.1388975*** (.0146243)	-.0466111*** (.009166)	-.0938055*** (.0118976)	-.0466111*** (.0089162)	-.0938055*** (.0118381)
Lna	.0308922*** (.0051603)	.0308922*** (.006129)	-.0143019** (.0077797)	-.0143019 (.0205886)	-.005902 (.0072363)	-.005902 (.0182923)	.0308922*** (.0051424)	-.0143019** (.0077797)	-.0024712 (.0042503)	-.0143019** (.0075677)	-.0024712 (.004229)
Lnli	-.2971257*** (.0708903)	-.2971257*** (.0580767)	-.041069 (.0497855)	-.041069 (.1040053)	-.0584754 (.0496225)	-.0584754 (.1008582)	-.2971257*** (.0706449)	-.041069 (.0497855)	-.2456887*** (.053122)	-.041069 (.0484287)	-.2456887*** (.0528561)
Lnci	.0318486*** (.0091361)	.0318486*** (.0099954)	.001208 (.0066607)	.001208 (.0208045)	.0028254 (.0066353)	.0028254 (.0199001)	.0318486*** (.0091045)	.001208 (.0066607)	.0106663* (.0075189)	.001208 (.0064792)	.0106663* (.0074813)
Lnri	.3927204** (.1924113)	.3927204** (.185731)	.5121446*** (.1388096)	.5121446* (.2779251)	.5112653*** (.138674)	.5112653** (.2667702)	.3927204** (.1917451)	.5121446*** (.1388096)	.339469*** (.1430151)	.5121446*** (.1350266)	.339469** (.1422993)
Lnsi	-.0171205*** (.0016137)	-.0171205*** (.0022062)	-.0034732** (.0018566)	-.0034732 (.0041063)	-.0056022*** (.0017674)	-.0056022* (.0042256)	-.0171205*** (.0016081)	-.0034732** (.0018566)	-.0037524*** (.0012752)	-.0034732** (.001806)	-.0037524*** (.0012688)
Lntmi	-.1581421*** (.0192989)	-.1581421*** (.0311555)	-.0400155*** (.0130148)	-.0400155** (.0214455)	-.0441478*** (.0130303)	-.0441478** (.020994)	-.1581421*** (.0192321)	-.0400155*** (.0130148)	-.043914*** (.0152349)	-.0400155*** (.0126601)	-.043914*** (.0151587)
_cons	.1897947*** (.0215206)	.1897947*** (.0310225)	.1978521*** (.022733)	.1978521** (.0910903)	.1905266*** (.0239484)	.1905266** (.0908364)	.1897947*** (.0214461)	.2972044*** (.0256259)	.2744315*** (.0174056)	.2972044*** (.0249275)	.2744315*** (.0173185)
pat	-.0083152 (.0065439)	-.0083152 (.0065344)	-.0075153** (.0035871)	-.0075153* (.005594)	-.0085018** (.0035754)	-.0085018* (.005336)	-.0083152 (.0065212)	-.0075153** (.0035871)	-.0084739* (.0048546)	-.0075153** (.0034893)	-.0084739* (.0048303)
Number of obs.	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302
Number of groups	62	62	62	62	62	62	62	62	62	62	62
F	F(8, 1293) = 52.81	F(8, 1293) = 31.23	F(8,1232) = 11.12	F(8,61) = 3.04	Wald chi2(8) = 97.28	Wald chi2(8) = 23.25	Wald chi2(8) = 425.40	Wald chi2(8) = 425.40	F(12, 1289) = 153.61	Wald chi2(69) = 6362.07	Wald chi2(12) = 1861.95
Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0061	Prob > chi2 = 0.0000	Prob > chi2 = 0.0031	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table VI : Regression results indicating impact on energy intensity (Lnei) taking only ECA for Dataset 2

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-VIII**	**Model-IX**	**Model-X**
	Pooled OLS (Lnei)	**Pooled OLS (Lnei) Robust**	**Fixed Effect (Lnei)**	**Fixed Effect (Lnei) Robust**	**Random Effect (Lnei)**	**Random Effect (Lnei) Robust**	**Generalised Least Square (Lnei)**	**Pooled OLS i.panelid (Lnei)**	**Pooled OLS i.industryid (Lnei)**	**GLS i.panelid (Lnei)**	**GLS i.industryid (Lnei)**
Lnpmi	-.1371822*** (.0146576)	-.1371822*** (.0282827)	-.0430094*** (.0092411)	-.0430094*** (.0223066)	-.0452684*** (.0092521)	-.0452684** (.0224693)	-.1371822*** (.0146069)	-.0430094*** (.0092411)	-.091832*** (.0119192)	-.0430094*** (.0089893)	-.091832*** (.0118596)
Lna	.0304975*** (.0051906)	.0304975*** (.006206)	-.0110011 (.0085818)	-.0110011 (.0187987)	-.0023576 (.0078551)	-.0023576 (.0171586)	.0304975*** (.0051726)	-.0110011 (.0085818)	-.0027496 (.004287)	-.0110011* (.008348)	-.0027496 (.0042655)
Lnli	-.2972097*** (.0720759)	-.2972097*** (.0588491)	-.0240349 (.0508157)	-.0240349 (.104944)	-.0380629 (.0507286)	-.0380629 (.1018959)	-.2972097*** (.0718264)	-.0240349 (.0508157)	-.2432481*** (.0540684)	-.0240349 (.0494308)	-.2432481*** (.0537978)
Lnci	.0315227*** (.0092278)	.0315227*** (.0101229)	.0002052 (.0066597)	.0002052 (.0210014)	.0015858 (.0066388)	.0015858 (.0202454)	.0315227*** (.0091959)	.0002052 (.0066597)	.0102255* (.0075606)	.0002052 (.0064782)	.0102255* (.0075227)
Lnri	.3868105** (.1939481)	.3868105** (.1879266)	.4744626*** (.1395588)	.4744626* (.2715061)	.4673189*** (.1394919)	.4673189** (.2632117)	.3868105** (.1932766)	.4744626*** (.1395588)	.3298438** (.1440759)	.4744626*** (.1357554)	.3298438** (.1433548)
Lnsi	-.0171812*** (.0016253)	-.0171812*** (.0022194)	-.0036159** (.0018621)	-.0036159 (.004051)	-.005687*** (.0017683)	-.005687* (.0042526)	-.0171812*** (.0016197)	-.0036159** (.0018621)	-.003778*** (.001283)	-.0036159** (.0018114)	-.003778*** (.0012766)
Lntmi	-.1594422*** (.0192807)	-.1594422*** (.0309587)	-.0414735*** (.0129832)	-.0414735** (.0218356)	-.0457153*** (.0129953)	-.0457153** (.0213587)	-.1594422*** (.019214)	-.0414735*** (.0129832)	-.0453724*** (.0152277)	-.0414735*** (.0126294)	-.0453724*** (.0151515)
_cons	.1930586*** (.0213378)	.1930586*** (.0308333)	.1918422*** (.0242306)	.1918422** (.0895052)	.1838008*** (.0249862)	.1838008** (.0901774)	.1930586*** (.021264)	.2904916*** (.0271929)	.2775944*** (.0172788)	.2904916*** (.0264518)	.2775944*** (.0171923)
eca	-.0034545 (.0059609)	-.0034545 (.0061556)	-.0077507** (.0037518)	-.0077507 (.0060741)	-.0090208*** (.0036721)	-.0090208* (.0063112)	-.0034545 (.0059403)	-.0077507** (.0037518)	-.0044222 (.0044391)	-.0077507** (.0036496)	-.0044222 (.0044169)
No of obs.	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302
Number of groups	62	62	62	62	62	62	62	62	62	62	62
F	F(8, 1293) = 52.60	F(8, 1293) = 30.21	F(8,1232) = 11.11	F(8,61) = 3.55	Wald chi2(8) = 97.69	Wald chi2(8) = 32.28	Wald chi2(8) = 423.69	F(69, 1232) = 87.24	F(12, 1289) = 153.20	Wald chi2(69) = 6361.31	Wald chi2(12) = 1856.92
Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0020	Prob > chi2 = 0.0000	Prob > chi2 = 0.0001	Prob > chi2 = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Annexure 4.2: Sensitivity Analysis to study impact on energy intensity of industries taking both PAT and ECA together

Table VI : Sensitivity analysis to study impact on energy intensity (Lnei) of industries using Pooled OLS (Robust) Model for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-IX**
Lnpmi	-.1431146*** (.039088)	-.144123*** (.0391235)		-.139422*** (.039483)	-.1761806*** (.0409883)	-.1243271*** (.0342897)	-.1272223*** (.0317186)	-.1415791*** (.0316063)	-.1377901*** (.0318486)
Lna					-.0367947*** (.0069513)	-.0334724*** (.0067918)	-.0212161*** (.007405)	-.0207488*** (.0073084)	-.0200123*** (.0069962)
Lnli									
Lnci							.0724079** (.0305967)	.0642911** (.0284239)	.0749003*** (.019678)
Lnri								1.217538*** (.3408226)	1.175346*** (.3245422)
Lnsi						-.0228817*** (.0029217)	-.022973*** (.0029222)		-.0191564*** (.0033092)
Lntmi									-.074856** (.0306986)
_cons	.1479377*** (.0051215)	.1489679*** (.0055224)		.1594447*** (.0085077)	.2878518*** (.0274835)			.3983353*** (.0518043)	.3721809*** (.0521016)
Pat		-.0051311 (.0112971)		.0008295 (.0117408)	.0062545 (.0116519)	.015541 (.0108079)	.0186313* (.0108386)	.020446* (.0106287)	.0212175** (.0106227)
Eca			-.0188321** (.009723)	-.0166019* (.009787)	-.0061475 (.0094775)	.0005208 (.009156)	.0014347 (.0089032)	.0014232 (.0088609)	.0030309 (.0088233)
No. of obs.	546	546	546	546	546	546	546	546	546
No of groups	26	26	26	26	26	26	26	26	26
F	F(1, 544) = 13.41	F(1, 544) = 0.03	F(1, 544) = 3.75	F(3, 542) = 5.05	F(1, 544) = 0.03	F(5, 540) = 19.29	F(6, 539) = 15.92	F(7, 538) = 25.15	F(8, 537) = 25.33
Prob > F	Prob > F = 0.0003	Prob > F = 0.8578	Prob > F = 0.0533	Prob > F = 0.0019	Prob > F = 0.8578	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000

Table VII : Sensitivity Analysis to study impact on energy intensity (Lnei) of industries using Fixed Effect (Robust) Model for Dataset 1

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII
Lnpmi	-.1092431** (.0567618)	-.1106344** (.0583224)	-.1034373** (.0522035)	-.1026379** (.0524034)	-.1028267** (.0540897)	-.1086994** (.0574789)	-.1051348** (.0573047)	-.0993077* (.0562048)
Lna					-.004715 (.0643663)	.0018666 (.0115359)	.0371847 (.0614559)	.0334147 (.058647)
Lnli								
Lnci							.0399154 (.0586586)	.0552505 (.064899)
Lnri								
Lnsi							-.0163594 (.0120954)	-.0150468 (.0122542)
Lntmi								-.0864 (.045289)
_cons	.1461634*** (.0029733)	.1470764*** (.0044316)	.1580117*** (.0141292)	.1579799*** (.0141612)	.1742543 (.2300952)	.2028012 (.2519612)		.1743873 (.237673)
pat		-.0044107 (.0112996)		.001955 (.0094875)	.0027885 (.0115459)	.0018666 (.0115359)	.0041242 (.0100728)	.0068826 (.0101017)
eca			-.0170134 (.0173068)	-.0175488 (.0171282)	-.0163255 (.0181799)	-.0191908 (.0183843)	-.0185685 (.0181843)	-.0146779 (.0186738)
Number of obs.	546	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26	26
F	F(1,25) = 3.70	F(2,25) = 1.91	F(2,25) = 1.98	F(3,25) = 1.34	F(4,25) = 1.53	F(5,25) = 1.33	F(6,25) = 7.80	F(7,25) = 4.43
Prob > F	Prob > F = 0.0657	Prob > F = 0.1688	Prob > F = 0.1585	Prob > F = 0.2843	Prob > F = 0.2247	Prob > F = 0.2828	Prob > F = 0.0001	Prob > F = 0.0026

Table VIII : Sensitivity Analysis to study impact on energy intensity (Lnei) of industries using Generalised Least Square Model for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**
Lnpmi	-.1431146*** (.0326906)	-.144123*** (.0327532)	-.139422*** (.0327887)	-.1761806*** (.0334159)	-.1243271*** (.0318779)	-.1272223*** (.0313749)	-.1237242*** (.0311626)
Lna				-.0367947*** (.0087034)	-.0334724*** (.0081654)	-.0212161** (.0085405)	-.0204163** (.0084808)
Lnli							
Lnci						.0724079*** (.0171067)	.0833841*** (.0173999)
Lnri							
Lnsi					-.0228817*** (.0026301)	-.022973*** (.0025881)	-.0200962*** (.0027557)
Lntmi							-.0795546*** (.0276028)
_cons	.1479377*** (.0045793)	.1489679*** (.005069)	.1594447*** (.0080303)	.2878518*** (.0313845)	.504928*** (.03857)	.4248987*** (.0424013)	.3961243*** (.0432504)
pat		-.0051311 (.0108364)	.0008295 (.0113764)	.0062545 (.0112679)	.015541 (.0106136)	.0186313* (.0104691)	.019518* (.0103949)
eca			-.0166019* (.0098862)	-.0061475 (.0100377)	.0005208 (.009438)	.0014347 (.0092894)	.0031429 (.0092385)
Number of obs.	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26
F	Wald chi2(1) = 19.17	Wald chi2(2) = 19.40	Wald chi2(3) = 22.32	Wald chi2(4) = 40.92	Wald chi2(5) = 122.28	Wald chi2(6) = 144.21	Wald chi2(7) = 154.71
Prob > F	Prob > chi2 = 0.0000	Prob > chi2 = 0.0001	Prob > chi2 = 0.0001	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Annexure 5.1: <u>Regression results to study the impact on profitability of industries pre and post policy intervention</u>

Table IX : Regression results indicating impact on profitability (Lnpmi) taking Both PAT and ECA together for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**
	Pooled OLS (Lnpmi) Robust	**Fixed Effect (Lnpmi) Robust**	**Random Effect (Lnpmi) Robust**	**Pooled OLS i.panelid (Lnpmi)**	**Pooled OLS i.industryid (Lnpmi)**	**GLS i.panelid (Lnpmi)**	**GLS i.industryid (Lnpmi)**
Lnei	-.2669411*** (.0506324)	-.3444267*** (.1245833)	-.323385*** (.0917314)	-.3444267*** (.0822532)	- .3794263*** (.0650346)	- .3444267*** (.0795732)	- .3794263*** (.064316)
Lna	-.0720701*** (.0120861)	.0410489 (.0756314)	-.0562105*** (.0223509)	.0410489 (.0451909)	- .0560783*** (.0136569)	.0410489 (.0437185)	- .0560783*** (.0135059)
Lnli	.1564516 (.2443103)	-.0538582 (.514485)	.0125798 (.4829487)	-.0538582 (.1581731)	.0994408 (.1423207)	-.0538582 (.1530195)	.0994408 (.1407481)
Lnci	.0156037 (.0316486)	-.0182136 (.0614666)	-.0200714 (.0597681)	-.0182136 (.0245059)	.0091563 (.0237478)	-.0182136 (.0237075)	.0091563 (.0234853)
Lnri	1.511616*** (.3961374)	1.129155 (1.417687)	1.007635 (1.089098)	1.129155* (.7084217)	.7624188* (.4690555)	1.129155* (.6853399)	.7624188* (.4638724)
Lnsi	.0098924*** (.0031937)	-.0286174* (.0197481)	-.0052397 (.0099519)	-.0286174*** (.0102016)	-.0003063 (.0044427)	- .0286174*** (.0098692)	-.0003063 (.0043936)
Lntmi	.0250999 (.0380501)	.0290429 (.0777592)	.0316238 (.072309)	.0290429 (.0406122)	.0143526 (.0385498)	.0290429 (.039289)	.0143526 (.0381238)
_cons	.1920963*** (.0614693)	.2304562 (.3141335)	.3280556** (.3280556)	.2760276** (.1397479)	.3520804*** (.0767294)	.2760276** (.1351946)	.3520804*** (.0758816)
pat	-.0143799* (.010047)	-.0246651* (.0169012)	-.0161547* (.0121391)	-.0246651* (.0136535)	-.0155818 (.0139101)	-.0246651* (.0132086)	-.0155818 (.0137564)
eca	.0303353* (.0176983)	.0198761 (.0311995)	.0337327 (.0308269)	.0198761* (.0154243)	.0295403** (.0131468)	.0198761* (.0149218)	.0295403** (.0130016)
Number of obs.	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26
F	F(9, 536) = 14.11	F(9,25) = 8.41	Wald chi2(9) = 71.04	F(34, 511) = 10.97	F(11, 534) = 11.49	Wald chi2(34) = 398.67	Wald chi2(11) = 129.24
Prob > F	0.0000	0.0000	Prob > chi2 = 0.0000	0.0000	0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table X : Regression results indicating impact on profitability (Lnpmi) taking only ECA for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-VIII**	**Model-IX**	**Model-X**
	Pooled OLS (Lnpmi)	**Pooled OLS (Lnpmi) Robust**	**Fixed Effect (Lnpmi)**	**Fixed Effect (Lnpmi) Robust**	**Random Effect (Lnpmi)**	**Random Effect (Lnpmi) Robust**	**Generalised Least Square (Lnpmi)**	**Pooled OLS i.panelid (Lnpmi)**	**Pooled OLS i.industryid (Lnpmi)**	**GLS i.panelid (Lnpmi)**	**GLS i.industryid (Lnpmi)**
Lnei	-.273741*** (.0584958)	-.273741*** (.0496907)	-.3546047*** (.0822412)	-.3546047*** (.1246229)	-.3339124*** (.0755206)	-.3339124*** (.0895263)	-.273741*** (.0580117)	-.3546047*** (.0822412)	-.3848886*** (.064867)	-.3546047*** (.0796394)	-.3848886*** (.0642102)
Lna	-.0735635*** (.0119225)	-.0735635*** (.011941)	.0076019 (.041315)	.0076019 (.0605919)	-.0645852*** (.0233866)	-.0645852*** (.0201721)	-.0735635*** (.0118238)	.0076019 (.041315)	-.0582272*** (.0135247)	.0076019 (.040008)	-.0582272*** (.0133877)
Lnli	.168078 (.1438706)	.168078 (.2459981)	-.0369906 (.1582459)	-.0369906 (.5126071)	.0259067 (.1529039)	.0259067 (.4829196)	.168078 (.1426799)	-.0369906 (.1582459)	.1119206 (.1419178)	-.0369906 (.1532397)	.1119206 (.140481)
Lnci	.0175771 (.0240288)	.0175771 (.0315479)	-.0139856 (.0244478)	-.0139856 (.0636606)	-.0171197 (.0238778)	-.0171197 (.0601684)	.0175771 (.0238299)	-.0139856 (.0244478)	.011409 (.0236681)	-.0139856 (.0236743)	.011409 (.0234285)
Lnri	1.538016*** (.4443498)	1.538016*** (.3937173)	1.221811* (.7081227)	1.221811 (1.460114)	1.086579* (.6262001)	1.086579 (1.098145)	1.538016*** (.4406724)	1.221811* (.7081227)	.7898933* (.4685254)	1.221811* (.6857206)	.7898933* (.4637818)
Lnsi	.009538*** (.0038724)	.009538*** (.0032633)	-.0282025*** (.0102215)	-.0282025* (.0194754)	-.0062454 (.0067502)	-.0062454 (.0095063)	.009538*** (.0038403)	-.0282025*** (.0102215)	-.0006899 (.0044305)	-.0282025*** (.0098981)	-.0006899 (.0043856)
Lntmi	.0241771 (.0379653)	.0241771 (.0384208)	.0229757 (.0405625)	.0229757 (.0745653)	.0284385 (.0394927)	.0284385 (.0702567)	.0241771 (.0376511)	.0229757 (.0405625)	.0141494 (.0385585)	.0229757 (.0392793)	.0141494 (.0381681)
_cons	.2002312*** (.063041)	.2002312*** (.0615844)	.3398492*** (.1189088)	.3398492* (.2573336)	.3659686*** (.0938906)	.3659686*** (.1551132)	.2002312*** (.0625192)	.3857714*** (.1261311)	.3623716*** (.0761956)	.3857714*** (.1221408)	.3623716*** (.0754242)
eca	.0268069** (.0127666)	.0268069* (.0175834)	.023193* (.0153485)	.023193 (.0300209)	.0322402*** (.013059)	.0322402 (.0309205)	.0268069** (.0126609)	.023193* (.0153485)	.0258979** (.0127414)	.023193* (.0148629)	.0258979** (.0126124)
Number of obs.	546	546	546	546	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26	26	26	26	26
F	F(8, 537) = 12.49	F(8, 537) = 12.85	F(8,512) = 4.55	F(8,25) = 7.64	Wald chi2(8) = 38.14	Wald chi2(8) = 64.19	Wald chi2(8) = 101.64	F(33, 512) = 11.16	F(10, 535) = 12.51	Wald chi2(33) = 392.67	Wald chi2(10) = 127.65
Prob > F	0.0000	0.0000	0.0000	0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	0.0000	0.0000	0.0000	Prob > chi2 = 0.0000

Table XI : Regression results indicating impact on profitability (Lnpmi) taking only PAT for Dataset 1

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-VIII	Model-IX	Model-X
	Pooled OLS (Lnpmi)	**Pooled OLS (Lnpmi) Robust**	**Fixed Effect (Lnpmi)**	**Fixed Effect (Lnpmi) Robust**	**Random Effect (Lnpmi)**	**Random Effect (Lnpmi) Robust**	**Generalised Least Square (Lnpmi)**	**Pooled OLS i.panelid (Lnpmi)**	**Pooled OLS i.industryid (Lnpmi)**	**GLS i.panelid (Lnpmi)**	**GLS i.industryid (Lnpmi)**
Lnei	-.2785744*** (.0588872)	-.2785744*** (.0506943)	-.3603807*** (.0813685)	-.3603807*** (.1252827)	-.3463145*** (.0758243)	-.3463145*** (.0888897)	-.2785744*** (.0583999)	-.3603807*** (.0813685)	-.3971547*** (.064798)	-.3603807*** (.0787943)	-.3971547*** (.064142)
Lna	-.0710945*** (.012052)	-.0710945*** (.0119244)	.0734936** (.0375513)	.0734936 (.0819466)	-.0359027* (.0230976)	-.0359027* (.0205014)	-.0710945*** (.0119522)	.0734936** (.0375513)	-.0530077*** (.0136396)	.0734936** (.0363634)	-.0530077*** (.0135015)
Lnli	.2733784** (.1355453)	.2733784 (.2137908)	.0183916* (.1479978)	.0183916 (.4289103)	.171481 (.1409253)	.171481 (.3793438)	.2733784** (.1344235)	.0183916 (.1479978)	.2116188* (.1337803)	.0183916 (.1433158)	.2116188* (.1324258)
Lnci	.0130353 (.0241753)	.0130353 (.0320486)	-.0216929 (.0243724)	-.0216929 (.0608519)	-.0270676 (.0239479)	-.0270676 (.0591904)	.0130353 (.0239753)	-.0216929 (.0243724)	.0062509 (.0238021)	-.0216929 (.0236014)	.0062509 (.0235611)
Lnri	1.496048*** (.4468004)	1.496048*** (.3940501)	1.194111* (.7070818)	1.194111 (1.417597)	1.040288* (.6322421)	1.040288 (1.101427)	1.496048*** (.4431027)	1.194111* (.7070818)	.7618075* (.470827)	1.194111* (.6847126)	.7618075* (.4660601)
Lnsi	.0106854*** (.0038878)	.0106854*** (.0030952)	-.0298085*** (.0101662)	-.0298085* (.0211082)	-.0029005 (.0067758)	-.0029005 (.0087633)	.0106854*** (.0038556)	-.0298085*** (.0101662)	.0005896 (.0044414)	-.0298085*** (.0098446)	.0005896 (.0043965)
Lntmi	.0352699 (.0378643)	.0352699 (.0403861)	.0365126 (.0402223)	.0365126 (.0723151)	.0453987 (.0393934)	.0453987 (.0661617)	.0352699 (.0375509)	.0365126 (.0402223)	.0207106 (.038591)	.0365126 (.0389499)	.0207106 (.0382003)
_cons	.1961805*** (.0637697)	.1961805*** (.0609439)	.1368232 (.1117153)	.1368232 (.2548733)	.2490369*** (.0941758)	.2490369* (.1397075)	.1961805*** (.063242)	-.0267595** (.0135651)	.3472014*** (.0769884)	.1819277* (.1154559)	.3472014*** (.0762089)
pat	-.0058919 (.0136863)	-.0058919 (.0107333)	-.0267595** (.0135651)	-.0267595* (.0156095)	-.0131851 (.0127967)	-.0131851 (.0142023)	-.0058919 (.0135731)	-.0267595** (.0135651)	-.0078514 (.0135288)	-.0267595** (.013136)	-.0078514 (.0133918)
Number of obs.	546	546	546	546	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26	26	26	26	26
F	F(8, 537) = 11.87	F(8, 537) = 15.46	F(8,512) = 4.76	F(8,25) = 8.57	Wald chi2(8) = 32.80	Wald chi2(8) = 75.51	Wald chi2(8) = 96.58	F(33, 512) = 11.24	F(10, 535) = 12.04	Wald chi2(33) = 395.61	Wald chi2(10) = 122.91
Prob > F	0.0000	0.0000	0.0000	0.0000	Prob > chi2 = 0.0001	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	0.0000	0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table XII : Regression results indicating impact on profitability (Lnpmi) taking PAT and ECA for Dataset 2

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**
	Pooled OLS (Lnpmi) Robust	**Fixed Effect (Lnpmi) Robust**	**Random Effect (Lnpmi) Robust**	**Pooled OLS i.panelid (Lnpmi)**	**Pooled OLS i.industryid (Lnpmi)**	**GLS i.panelid (Lnpmi)**	**GLS i.industryid (Lnpmi)**
Lnei	-.4640543*** (.0770818)	-.4106149** (.1969203)	-.4214922*** (.1684951)	-.4106149*** (.0863746)	-.4842185*** (.0620642)	-.4106149*** (.0839865)	-.4842185*** (.0617297)
Lna	-.0096929 (.0094239)	-.0791424* (.049959)	-.041841* (.0267638)	-.0791424*** (.0281379)	-.0494184*** (.009723)	-.0791424*** (.0273599)	-.0494184*** (.0096706)
Lnli	-.3177158 (.2209722)	-1.108547** (.4815064)	-.8808985* (.4908347)	-1.108547*** (.1521356)	-.5345493*** (.1233294)	-1.108547*** (.1479294)	-.5345493*** (.1226646)
Lnci	-.0737293** (.0332394)	-.2334842*** (.0610037)	-.1920391*** (.0614972)	-.2334842*** (.0192299)	-.163366*** (.0166247)	-.2334842*** (.0186982)	-.163366*** (.0165351)
Lnri	1.378035*** (.3859057)	1.530923** (.7195213)	1.642588** (.6747972)	1.530923*** (.4260221)	.8674662*** (.3280102)	1.530923*** (.4142435)	.8674662*** (.326242)
Lnsi	.0133727*** (.004097)	.0094043 (.0080563)	.0101762* (.0063498)	.0094043* (.0057008)	.0167756*** (.0028996)	.0094043*** (.0055431)	.0167756*** (.002884)
Lntmi	-.0700587 (.0592281)	.0971013* (.0560447)	.0556608 (.0557471)	.0971013** (.039804)	.0628448** (.0348112)	.0971013** (.0387035)	.0628448* (.0346236)
_cons	.004871 (.0304477)	.3678896** (.1669519)	.2077951** (.0992344)	.4752671*** (.0917826)	.1867267*** (.0430708)	.4752671*** (.089245)	.1867267*** (.0428386)
pat	-.0403238*** (.0144515)	-.0199512 (.0129641)	-.0294257** (.0143024)	-.0199512* (.0109762)	-.0331704*** (.0113777)	-.0199512* (.0106727)	-.0331704*** (.0113164)
eca	.0237674** (.0116462)	.0501326*** (.0184614)	.0375444** (.016735)	.0501326*** (.0114055)	.0301833*** (.0103876)	.0501326*** (.0110901)	.0301833*** (.0103316)
Number of obs.	1302	1302	1302	1302	1302	1302	1302
Number of groups	62	62	62	62	62	62	62
F	F(9, 1292) = 16.21	F(9,61) = 9.47	Wald chi2(9) = 97.16	F(70, 1231) = 14.93	F(13, 1288) = 36.58	Wald chi2(70) = 1105.73	Wald chi2(13) = 480.76
Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table XIII : Regression results indicating impact on profitability (Lnpmi) taking only PAT for Dataset 2

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-VIII**	**Model-IX**	**Model-X**
	Pooled OLS (Lnpmi)	**Pooled OLS (Lnpmi) Robust**	**Fixed Effect (Lnpmi)**	**Fixed Effect (Lnpmi) Robust**	**Random Effect (Lnpmi)**	**Random Effect (Lnpmi) Robust**	**Generalised Least Square (Lnpmi)**	**Pooled OLS i.panelid (Lnpmi)**	**Pooled OLS i.industryid (Lnpmi)**	**GLS i.panelid (Lnpmi)**	**GLS i.industryid (Lnpmi)**
Lnei	-.46649*** (.0492865)	-.46649*** (.0777167)	-.4410644*** (.0867341)	-.4410644** (.2023543)	-.4433295*** (.0734284)	-.4433295*** (.0734284)	-.46649*** (.0491159)	-.4410644*** (.0867341)	-.4904555*** (.0622059)	-.4410644*** (.0843704)	-.4904555*** (.0618946)
Lna	-.0068167 (.0095851)	-.0068167 (.0091265)	-.0130625 (.0239613)	-.0130625 (.053186)	-.0176994 (.0167265)	-.0176994 (.0167265)	-.0068167 (.0095519)	-.0130625 (.0239613)	-.0451352*** (.0096383)	-.0130625 (.0233083)	-.0451352*** (.0095901)
Lnli	-.2677914** (.1305828)	-.2677914 (.2148927)	-.9844411*** (.1506)	-.9844411** (.4748204)	-.7669448*** (.1438012)	-.7669448*** (.1438012)	-.2677914** (.1301307)	-.9844411*** (.1506)	-.4716449*** (.1217646)	-.9844411*** (.1464957)	-.4716449*** (.1211552)
Lnci	-.0788677*** (.016678)	-.0788677*** (.0327664)	-.2399405*** (.0193157)	-.2399405*** (.0631127)	-.1996313*** (.0184593)	-.1996313*** (.0184593)	-.0788677*** (.0166202)	-.2399405*** (.0193157)	-.1692765*** (.0165474)	-.2399405*** (.0187893)	-.1692765*** (.0164646)
Lnri	1.291578*** (.3513544)	1.291578*** (.4012855)	1.369201*** (.4275745)	1.369201** (.7413876)	1.479907*** (.4062707)	1.479907*** (.4062707)	1.291578*** (.3501379)	1.369201*** (.4275745)	.7646484** (.3270362)	1.369201*** (.4159217)	.7646484** (.3253994)
Lnsi	.0142323*** (.0030579)	.0142323*** (.004031)	.006973 (.0057159)	.006973 (.0086684)	.0113625** (.0045079)	.0113625*** (.0045079)	.0142323*** (.0030473)	.006973 (.0057159)	.0178801*** (.0028829)	.006973 (.0055601)	.0178801*** (.0028685)
Lntmi	-.0713576** (.0362201)	-.0713576 (.0601345)	.1018906** (.0400838)	.1018906* (.1018906)	.0576399* (.0388599)	.0576399* (.0388599)	-.0713576** (.0360947)	.1018906** (.0400838)	.061113* (.0349065)	.1018906*** (.0389914)	.061113* (.0347318)
_cons	.0032102 (.040608)	.0032102 (.0301045)	.1940406*** (.0718353)	.1940406* (.1473958)	.1375792** (.0604303)	.1375792** (.0604303)	.0032102 (.0404674)	.2939462*** (.0825972)	.1824562*** (.0431698)	.2939462*** (.0803462)	.1824562*** (.0429538)
pat	-.0340249*** (.0119626)	-.0340249** (.0150244)	-.0230706** (.0110344)	-.0230706* (.0133201)	-.0261125** (.0106514)	-.0261125** (.0106514)	-.0340249*** (.0119212)	-.0230706** (.0110344)	-.0254021** (.0110911)	-.0230706** (.0107336)	-.0254021** (.0110356)
No of obs.	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302	1302
No. of groups	62	62	62	62	62	62	62	62	62	62	62
F	F(8, 1293) = 25.24	F(8, 1293) = 17.74	F(8,1232) = 35.36	F(8,61) = 10.14	Wald chi2(8) = 244.28	Wald chi2(8) = 244.28	Wald chi2(8) = 203.36	F(69, 1232) = 14.65	F(12, 1289) = 38.71	Wald chi2(69) = 1068.53	Wald chi2(12) = 469.15
Prob > F	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Annexure 5.2: Sensitivity Analysis to study impact on profitabilty of industries taking both PAT and ECA together

Table XIV : Sensitivity analysis to study impact on profitability (Lnpmi) of industries using Pooled OLS Robust Model for Dataset 1

Lnei	-.2369524*** (.0492464)	-.237628*** (.0492083)	-.2299014*** (.0499129)	-.2749745*** (.0485247)	-.2180016*** (.0514816)	-.3413149** (.1491026)	-.3607688** (.1668821)
Lna				-.074606*** (.0148454)	-.073106*** (.014994)	-.0308204 (.0626598)	.0291436 (.061472)
Lnsi					.0100197*** (.0026254)		-.025566 (.0167413)
_cons	.0856605 (.0073878)	.0899448*** (.00768)	.0752036*** (.0134798)	.3395339*** (.0515927)	.2246118*** (.0623139)	.1986809 (.2264252)	.2524525 (.2751358)
pat		-.0219945** (.009823)	-.029426** (.0108334)	-.0159158 (.010891)	-.0201038** (.0107046)	-.023372 (.0211969)	-.024683 (.0208984)
eca			.0211002* (.014193)	.0394689*** (.0145289)	.0363512** (.014632)	.0268149 (.0204779)	.0208282 (.0181528)
Number of obs.	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26
F	F(1, 544) = 23.15	F(2, 543) = 18.69	F(3, 542) = 14.33	F(4, 541) = 18.46	F(5, 540) = 20.78	F(4,25) = 8.72	F(5,25) = 8.27
Prob > F	0.0000	0.000	0.0000	0.0000	0.0000	0.0001	0.0001

Table XV : Sensitivity analysis to study impact on profitability (Lnpmi) of industries using Fixed Effect Robust Model for Dataset 1

Lnei	-.3610328** (.1406484)	-.3632225** (.1429559)	-.3477038** (.1385922)	-.3413149** (.1491026)	-.3607688** (.1668821)
Lna				-.0308204 (.0626598)	.0291436 (.061472)
Lnsi					-.025566 (.0167413)
_cons	.1030865*** (.0197528)	.107632** (.1429559)	.0933325*** (.0226182)	.1986809 (.2264252)	.2524525 (.2751358)
Pat		-.0222496 (.0138356)	-.0288594** (.0133109)	-.023372 (.0211969)	-.024683 (.0208984)
Eca			.0110348 (.0163298)	.0268149 (.0204779)	.0208282 (.0181528)
Number of obs.	546	546	546	546	546
Number of groups	26	26	26	26	26
F	F(1,25) = 6.59	F(2,25) = 11.07	F(2,25) = 3.36	F(4,25) = 8.72	F(5,25) = 8.27
Prob > F	0.0166	0.0004	0.0509	0.0001	0.0001

Table XVI: Sensitivity analysis to study impact on profitability (Lnpmi) of industries using Generalized Least Square Model for Dataset 1

Lnei	-.2369524** (.0541254)	-.237628*** (.0540031)	-.2299014*** (.0540673)	-.2749745*** (.052154)	-.2180016*** (.0558964)
Lna				-.074606*** (.0105784)	-.073106** (.0105223)
Lnsi					.0100197** (.0036915)
_cons	.0856605*** (.0093619)	.0899448*** (.0097242)	.0752036*** (.0131436)	.3395339*** (.0395353)	.2246118*** (.0577484)
pat		-.0219945 (.0138854)	-.029426** (.0145543)	-.0159158 (.0140645)	-.0201038 (.0140556)
eca			.0211002* (.0126958)	.0394689*** (.0124301)	.0363512** (.0124004)
Number of obs.	546	546	546	546	546
Number of groups	26	26	26	26	26
F	Wald chi2(1) = 19.17	Wald chi2(2) = 21.76	Wald chi2(3) = 24.63	Wald chi2(4) = 76.62	Wald chi2(5) = 85.02
Prob > F	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Annexure 5.3: Regression results to study the impact on production of industries pre and post policy intervention

Table XVII : Regression results indicating impact on production (Sales) taking Both PAT and ECA together for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**
	Pooled OLS (Sales)Robust	**Fixed Effect (Sales) Robust**	**Random Effect (Sales) Robust**	**Pooled OLS i.panelid (Sales)**	**Pooled OLS i.industryid (Sales)**	**GLS i.panelid (Sales)**	**GLS i.industryid (Sales)**
Energy	.7019173* (.7248487)	-.6923738* (1.354903)	.5287605* (.8369783)	-.6923738* (.2874019)	.758142* (.297634)	-.6923738* .(2780378)	.758142* (.297634)
Profits	1.458229** (.6083608)	.5203754* (.4366283)	1.360518*** .1779631	.5203754*** (.1389747)	1.352623*** (.1503946)	.5203754*** (.1344466)	1.352623*** (.1503946)
Age	-11.5516* (11.65993)	-20.95599* (67.33784)	-13.60708* (29.78426)	-20.95599* (145.4551)	-48.45927* (27.35277)	-20.95599* (140.7159)	-48.45927* (27.35277)
Labor	5.621188*** (1.694318)	9.167343** (3.752826)	5.629059* (2.29272)	9.167343*** (1.18059)	5.983022*** (1.127393)	9.167343*** (1.142124)	5.983022*** (1.127393)
Capital	.0924468* (.1198316)	-.0208834* (.0550936)	.0798108* (.0496641)	-.0208834* (.0196753)	.0901561*** (.0217973)	-.0208834* (.0190342)	.0901561*** (.0217973)
Repairs	2.23458* (7.766587)	18.71569* (14.37277)	5.483151* (12.42813)	18.71569*** (3.233579)	7.687784** (3.410858)	18.71569*** (3.128222)	7.687784** (3.410858)
Techimp	1.077296*** (.0303648)	1.113572*** (.0224037)	1.081788*** (.0180935)	1.113572*** (.0100399)	1.066678*** (.0111637)	1.113572*** (.0097128)	1.066678*** (.0111637)
pat	2070.888* (1292.945)	1835.305* (1707.256)	2131.099* (2048.993)	1835.305* (1443.183)	1753.732* (1296.53)	1835.305* (1396.161)	1753.732* (1296.53)
eca	-927.6809* (834.0569)	-207.6838* (791.5523)	-764.3637* (681.4512)	-207.6838* (1437.978)	-954.5888* (1135.348)	-207.6838* (1391.126)	-954.5888* (1135.348)
_cons	3692.871*** (816.9353)	4646.96** (2262.923)	3769.563* (1989.644)	3769.563* (1989.644)	-2376.541* (2257.752)	-244.0303* (5038.32)	-2376.541* (2257.752)
Number of obs.	546	546	546	546	54	546	546
Number of groups	26	26	26	26	26	26	26
F	F(9,25) =2.30e+07	Wald chi2(9) =110757.39	Wald chi2(9) =130523.57	Wald chi2(9) =130523.57	Wald chi2(34) =212201.38	Wald chi2(11) =135464.18	F(8,537) =16026.71
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table XVIII : Regression results indicating impact on production (Sales) taking only PAT for Dataset 1

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-VIII	Model-IX	Model-X
	Pooled OLS (Sales)	**Pooled OLS (Sales)Robust**	**Fixed Effect (Sales)**	**Fixed Effect (Sales) Robust**	**Random Effect (Sales)**	**Random Effect (Sales) Robust**	**Generalised Least Square (Sales)**	**Pooled OLS i.panelid (Sales)**	**Pooled OLS i.industryid (Sales)**	**GLS i.panelid (Sales)**	**GLS i.industryid (Sales)**
Energy	.7386792* (.2986152)	.7386792* (.7277613)	-.6905215* (.286841)	-.6905215* (1.354066)	.5591906* (.3009361)	.5591906* (.8244863)	.7386792* (.2961439)	-.6905215* (.286841)	.7965507** (.2940269)	-.6905215** (.2777665)	.7965507*** (.29105)
Profits	1.461622*** (.1490453)	1.461622* (.607905)	.5198798*** (.1387994)	.5198798* (.4362049)	1.362989*** (.1473083)	1.362989*** (.176036)	1.461622*** (.1478118)	.5198798*** (.1387994)	1.358958*** (.1501646)	.5198798*** (.1344083)	1.358958*** (.1486443)
Age	-14.10011* (22.89181)	-14.10011* (11.79106)	-36.8849* (94.74238)	-36.8849* (64.55699)	-16.71945* (26.45533)	-16.71945* (30.13099)	-14.10011* (22.70236)	-36.8849* (94.74238)	-52.53004* (26.91349)	-36.8849 (91.74512)	-52.53004** (26.64101)
Labor	5.393172*** (1.099954)	5.393172*** (1.684168)	9.160829*** (1.1786)	9.160829** (.0551594)	5.427711*** (1.116271)	5.427711* (2.233878)	5.393172*** (1.090851)	9.160829*** (1.1786)	5.737083*** (1.088487)	9.160829*** (1.141314)	5.737083*** (1.077466)
Capital	.937741*** (.0220737)	.0937741* (.1195984)	-.0207486* (.0196343)	-.0207486* (.0551594)	.0808956*** (.021655)	.0808956* (.049317)	.0937741*** (.021891)	-.0207486* (.0196343)	.0915948*** (.0217241)	-.0207486 (.0190132)	.0915948*** (.0215042)
Repairs	2.276823* (3.115192)	2.276823* (7.777321)	18.71927*** (3.230391)	18.71929* (14.36444)	5.515783* (3.212022)	5.515783* (12.45646)	2.276823* (3.089411)	18.71927*** (3.230391)	7.620075** (3.408973)	18.71927*** (3.128195)	7.620075** (3.374459)
Techimp	1.077366*** (.0109709)	1.077366* (.0303825)	1.113569*** (.0100303)	1.113569*** (.0223737)	1.081975*** (.0108464)	1.081975*** (.0180505)	1.077366*** (.0108801)	1.113569*** (.0100303)	1.066951*** (.011156)	1.113569*** (.009713)	1.066951*** (.011043)
pat	3239.164*** (1123.14)	1825.99* (1245.336)	1922.132* (1310.753)	1922.132* (1858.486)	1946.551** (1240.532)	1946.551* (2093.852)	1852.99* (1257.528)	1922.132* (1310.753)	1528.623* (1268.237)	1922.132* (1269.286)	1528.623 (1255.397)
_cons.	3239.164*** (1123.14)	3239.164*** (677.9465)	5172.637* (3836.585)	5172.637* (2062.969)	5172.637* (2062.969)	3445.131* (1868.447)	3239.164*** (1113.845)	224.5134* (4070.276)	-2669.045* (2230.177)	224.5134 (3941.509)	-2669.045 (2207.598)
No of obs.	546	546	546	546	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26	26	26	26	26
F	F(8,537) =5962.45	F(8,512) =9957.01	F(8,25) =2.30e+07	Wald chi2(8) =110795.24	Wald chi2(8) =5.79e+06	Wald chi2(8) =130362.55	F(33,512) =6029.67	F(33,512) =6029.67	Wald chi2(33) =212192.70	Wald chi2(33) = 212192.70	Wald chi2(10) = 135284.36
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Prob > chi2 = 0.0000	Prob > chi2 = 0.0000

Table XIX : Regression results indicating impact on production (Sales) taking only ECA for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-VIII**	**Model-IX**	**Model-X**
	Pooled OLS (Sales)	**Pooled OLS (Sales)Robus t**	**Fixed Effect (Sales)**	**Fixed Effect (Sales) Robust**	**Random Effect (Sales)**	**Random Effect (Sales) Robust**	**Generalised Least Square (Sales)**	**Pooled OLS i.panelid (Sales)**	**Pooled OLS i.industryid (Sales)**	**GLS i.panelid (Sales)**	**GLS i.industryid (Sales)**
Energy	.7462672* (.3012549)	.7462672* (.7216138)	-.6517101** (.2857897)	-.6517101* (1.359033)	.5773226* (.3037113)	.5773226* (.8222295)	.7462672* (.2987617)	-.6517101** (.2857897)	.7936224** (.2967057)	-.6517102* (.2767485)	.7936224** (.2937017)
Profits	1.427535*** (.1481036)	1.427535* (.5998931)	.5092322*** (.1387817)	.5092322* (.4322781)	1.328646*** (.1464505)	1.328646*** (.2040177)	1.427535 *** (.1468779	.5092322*** (.1387817)	1.321118*** (.1486952)	.5092322*** (.1343912)	1.321118*** (.1471898)
Age	-7.434552* (22.99992)	-7.434552* (11.42357)	103.8686* (107.4088)	103.8686* (150.0872)	-7.463435* (26.61526)	-7.463435* (27.84964)	-7.434502* (22.80958)	103.8668* (107.4088)	-43.27731* (27.10415)	103.8686* (104.0108)	-43.27731* (26.82973)
Labor	5.754502*** (1.134071)	5.754502*** (1.711078)	9.123589*** (1.1808)	9.123589** (3.778203)	5.791598*** (1.152982)	5.7915598** (2.368676)	5.754502*** (1.124686)	9.123589*** (1.1808)	6.123755*** (1.123452)	9.123589*** (1.143444)	6.124755*** (1.112077)
Capital	.0929215*** (.0221705)	.0929215* (.1200524)	-.021011* (.0196869)	-.021011* (.0558664)	.0802104*** (.0217699)	.0802104* (.0512838)	.0929215*** (.021987)	-.021011* (.0196869)	.0903592*** (.0218137)	-.021011* (.0190641)	.0903592*** (.0215929)
Repairs	2.075941* (3.119428)	2.075941 (7.790721)*	18.61648*** (3.234586)	18.61648* (14.41134)	5.324452* (3.217266)	5.324452* (12.47428)	2.075941* (3.093612)	18.61648*** (3.234586)	7.808155** (3.412339)	18.61648*** (3.132257)	7.808155* (.0110559)
Techimp	1.078311*** (.0109716)	1.078311*** (.0300447)	1.114068*** (.0100384)	1.114068*** (.0218792)	1.082538*** (.010864)	.082538*** (.0173361)	1.078311*** (.108808)	1.114068*** (.0100384)	1.067049*** (.011169)	1.114068*** (.0097208)	1.067049*** (.0110559)
Eca	-507.8776* (1113.092)	-507.8776* (790.8798)	-969.4438* (1308.065)	-969.4438* (1268.194)	-365.6864* (1093.74)	-365.6864* (813.4931)	-507.8776* (1103.88)	-969.4438* (1308.065)	-637.4622* (1111.738)	-969.4438* (1266.683)	-637.4622* (1100.482)
_cons	3520.029*** (1251.824)	3520.029*** 796.8088	124.9755* (3920.425)	124.9755** (5706.118)	3515.761** (1361.355)	3515.761* (1936.128)	3520.029** (1241.464)	-4404.172* (4055.472)	-2864.946* (2230.419	-4404.172* (3927.173)	-2864.946* (2207.838)
No of obs.	546	546	546	546	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26	26	26	26	26
F	F(8,35) =15971.02	F(8,512) =9925.80	F(8,25) =2.08e+07	Wald chi2(8) =110427.07	Wald chi(8) =3.32e+06	Wald chi(8) =129909.53	F(33,512) =6010.85	F(10,535) =13228.00	Wald chis(2) =211530.19	Wald chi2(33) =211530.19	Wald chi2(10) =134999.76
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table XX : Regression results indicating impact on production (Sales) taking both PAT and ECA together for Dataset 2

	Model-II	**Model-IV**	**Model-VI**	**Model-VIII**	**Model-VIII**	**Model-IX**	**Model-X**
	Pooled OLS (Sales)Robust	**Fixed Effect (Sales) Robust**	**Random Effect (Sales) Robust**	**Pooled OLS i.panelid (Sales)**	**Pooled OLS i.industryid (Sales)**	**GLS i.panelid (Sales)**	**GLS i.industryid (Sales)**
Energy	.6300656* (.2887869)	.7810473 (.7843383)	.8454949 (.7403296)	.6300656*** (.1123068)	.886407*** (.1108944)	.7810473*** (.154341)	.886407*** (.1102956)
Profits	1.852401*** (.1186635)	1.839369*** (.2820057)	1.883868*** (.2290417)	1.852401*** (.056401)	1.938312*** (.0536261)	1.839369*** (.05789)	1.938312*** (.0533365)
Age	-9.022813 (11.64281)	294.116*** (98.58588)	18.51094 (32.64499)	-9.022813 (11.30697)	1.282224 (11.44194)	294.116*** (66.89985)	1.282224*** (11.38017)
Labor	1.681179*** (.4364702)	2.14579* (1.281025)	2.185874** (.8971817)	1.681176*** (.1481154)	1.827948*** (.1395442)	2.14579*** (.1838764)	1.827948*** (11.38017)
Capital	.4636871*** (.0323886)	.3865621*** (.0621992)	.4184467*** (.7138233)	.4636871*** (.0106305)	.4746365*** (.0101997)	.3865621*** (.0133047)	.4746365*** (.0101337)
Repairs	2.867662*** (.8315741)	2.223498* (.8387607)	2.355497*** (.7138233)	2.867662*** (.3127971)	2.554399*** (.2958472)	2.223498*** (.2648466)	2.554399*** (.2942498)
Techimp	1.395828*** (.1762442)	1.040254** (.3711835)	1.109991*** (.3734613)	1.395828*** (.0442454)	1.226092*** (.0438671)	1.040254*** (.0511543)	1.226092*** (.0436302)
pat	-418.4406 (673.2173)	-1886.495* (1170.932)	-214.7979 (773.4496)	-418.4406 (572.1377)	-519.4108 (536.9739)	-1886.495*** (663.0858)	-519.4108 (534.0747)
eca	1658.645*** (361.7873)	-292.993 (629.7618)	1729.441** (625.7537)	1658.645*** (497.1579)	1576.962*** (466.9637)	-292.993 (672.7835)	1576.962*** (464.4425)
_cons	1033.527** (443.5887)	-8317.919** (3859.003)	494.2503 (880.4631)	1033.527* (558.1559)	-117.8162 (694.11)	-10400.21*** (2716.89)	-117.8162 (690.3624)
Number of obs.	1300	1300	1300	1300	1300	1300	1300
Number of groups	62	62	62	62	62	62	62
F	F(9,1290) =717.28	F(9,61) =52.17	Wald chi2(9) =1224.88	F(70,1229) =706.98	F(13,1286) =2807.18	Wald chi2(70) =52347.84	F(8,1291) =3930.47
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table XXI : Regression results indicating impact on production (Sales) taking only PAT for Dataset 2

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-VIII	Model-IX	Model-X
	Pooled OLS (Sales)	**Pooled OLS (Sales)Robust**	**Fixed Effect (Sales)**	**Fixed Effect (Sales) Robust**	**Random Effect (Sales)**	**Random Effect (Sales) Robust**	**Generalised Least Square (Sales)**	**Pooled OLS i.panelid (Sales)**	**Pooled OLS i.industryid (Sales)**	**GLS i.panelid (Sales)**	**GLS i.industryid (Sales)**
Energy	.6602497*** .1128112	.6602497** (.2888225)	.780735*** (.1586819)	.780735 (.7841885)	.8871263*** (.1416562)	.8871263 (.7504433)	.6602497*** (.11242)	.780735*** (.1586819)	.9151159***.(.1110141)	.780735*** (.1543506)	.9151159*** (.1104576)
Profits	1.876512*** .0563705	1.876512*** (.1194694)	1.837972*** (.0594274)	1.837972*** (.2795253)	1.906544*** (.0558335)	1.906544*** (.2327648)	1.876512*** (.056175)	1.837972*** .0594274	1.961999*** (.0533798)	1.837972*** (.0578053)	1.961999*** (.0531123)
Age	-2.455456 11.22077	-2.455456 (11.21675)	270.4638*** (40.16154)	270.4638*** (75.16038)	59.0892** (22.29972)	59.0892** (29.483)	-2.455456 (11.18186)	270.4638***40.16154	8.2371 (11.30048)	270.4638*** (39.06531)	8.2371 (11.24383)
Labor	1.651941*** (.1490043)	1.651941*** (.4356637)	2.1463*** (.1890462)	2.1463* (1.282687)	2.159028*** (.1730115)	2.159028** (.8968069)	1.651941*** (.1484876)	2.1463*** .1890462	1.800098*** (.1398623 12)	2.1463*** (.183886)	1.800098*** (.1391612)
Capital	.4624855*** (.0107069(	.4624855*** (.0322174)	.3867025*** (.013675)	.3867025*** (.0623995)	.4187957*** (.0122113)	.4187857*** (.0563948)	.4624855*** (.0106697)	.3867025*** .013675	.4734973*** (.0102242)	.3867025*** (.0133018)	.4734973*** (.010173)
Repairs	2.808406*** (.3147178)	2.808406*** (.8306715)	2.222976*** (.2722956)	2.222976** (.8393343)	2.316411*** (.2760424)	2.316411*** (.6647355)	2.808406*** (.3136265)	2.222976*** .2722956	2.493887*** (.2964953)	2.222976*** (.2648632)	2.493887*** (.2950091)
Techimp	1.404786*** (.0445068)	1.404786*** (.1769133)	1.042004*** (.0524311)	1.042004** (.3686197)	1.116084*** (.0499571)	1.116084** (.377909)	1.404786*** (.0443525)	1.042004*** .0524311	1.232963*** (.0439966)	1.042004*** (.0509999)	1.232963*** (.0437761)
Pat	100.9248 (554.8276)	100.9248 (654.4243)	-1746.3*** (596.0083)	-1746.3** (3018.648)	-48.20521 (509.6952)	-48.20521 (768.5317)	100.9248 (552.9037)	-1746.3** 596.0083	-29.53161 (519.0946)	-1746.3** (579.7399)	-29.53161 (516.4926)
_cons	1816.972*** (510.2861)	1816.972*** (490.9105)	-7578.9*** (1548.568)	-7578.9** (2018.648)	-45.10706 (1005.399)	-45.10706 (837.0085)	1816.972*** (508.5167)	9619.164***2098.233	563.3105 (666.8395)	-9619.164*** (2040.96)	563.3105 (663.4969)
No. of obs.	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
Number of groups	62	62	62	62	62	62	62	62	62	62	62
F	F(8,1291) =775.91	F(8,1291) =775.91	F(8,1230) =877.66	F(8,61) =58.70	Wald chi(8) =11287.34	Wald chi(8) =960.13	Wald cji(2) =31662.96	F(69,1230) =717.71	F(12,1287) =3015.78	Wald chi(69) =52340.01	Wald chi(12) =36554.92
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table XXII : Regression results indicating impact on production (Sales) taking only ECA for Dataset 2

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-VIII	Model-IX	Model-X
	Pooled OLS (Sales)	**Pooled OLS (Sales)Robust**	**Fixed Effect (Sales)**	**Fixed Effect (Sales) Robust**	**Random Effect (Sales)**	**Random Effect (Sales) Robust**	**Generalised Least Square (Sales)**	**Pooled OLS i.panelid (Sales)**	**Pooled OLS i.industryid (Sales)**	**GLS i.panelid (Sales)**	**GLS i.industryid (Sales)**
Energy	.6305521*** (.1127188)	.6305521*** (.2892447)	.775233*** (.1591513)	.775233 (.8030288)	.8424735*** (.1410839)	.8424735 (.7450673)	.630552*** (.112328)	.775233*** (.1591513)	.8871396*** (.110889 8.00)	.775233*** (.1548072)	.8871396*** (.1103332)
Profits	1.857635*** (..0561513)	1.857635*** (.118193)	1.853577*** (.0594769)	1.853577*** (.2846121)	1.886647*** (.0554738)	1.886647*** (.2284508)	1.857635*** (.0559566)	1.853577*** (.0594769)	1.944602*** (.053229)	1.853577*** (.0578535)	1.944602*** (.0529622)
Age	-10.41732 (11.18612)	-10.41732 (11.40298)	156.1367*** (47.5217)	156.1367** (67.44013)	14.66508 (22.96726)	14.66508 (30.6433)	10.41732 (11.14733)	156.1367*** (47.5217)	-.5668986 (11.28084)	156.1367 (46.22456)	-.5668986 (11.22429)
Labor	1.681189*** (.1486614)	1.681189*** (.4376618)	2.129152*** (.1895279)	2.129152* (1.282936)	2.185129*** (.1721567)	2.185129** (.8953701)	1.681189*** (.1481459)	2.129152*** (.1895279)	1.827857*** (.1395407)	2.129152*** (.1843546)	1.827857*** (.1388412)
Capital	.4623251*** (.0105047)	.4623251*** (.0322369)	.3834121*** (.1895279)	.3834121*** (.0614858)	.4177134*** (.0119796)	.4177134*** (.0564828)	.4623251*** (.0104682)	.3834121*** (.013673)	.472926*** (.0100339)	.3834121*** (.0132998)	.472926*** (.0099836)
Repairs	2.876853*** (.3136966)	2.876853*** (.8314257)	2.214685*** (.2731062)	2.214685* (.8215483)	2.359083*** (.2746784)	2.359083*** (.7104506)	2.876853***(.3126088)	2.214685*** (.2731062)	2.566777*** (.2955629)	2.214685*** (.2656516)	2.566777*** (.2940814)
Techimp	1.394669*** (.04438)	1.394669*** (.1764132)	1.051108*** (.0526063)	1.051108** (.3716841)	1.109799*** (.0496883)	1.109799** (.373065)	1.394669***(.0442261)	1.051108*** (.0526063)	1.224962*** (.0438504)	1.051108*** (.0511704)	1.224962*** (.0436306)
eca	1559.712*** (480.1643)	1559.712*** (356.5104)	636.2763 (606.5604)	636.2763 (623.8383)	1713.411*** (454.0497)	1713.411** (615.3223)	1559.712***(478.4993)	636.2763 (606.5604)	1454.94*** (449.5906)	636.2763*** (590.004)	1454.94*** (447.337)
_cons	1559.712** (554.6929)	1090.694** (445.5472)	-3611.301** (1601.435)	-3611.301* (2303.43)	632.6706 (956.4805)	632.6706 (896.0789)	1090.694* (552.7695)	-5473.404* (2158.903)	-39.23785 (689.3227)	-5473.404* (2099.975)	-39.23785 (685.8674)
No of obs.	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
Number of groups	62	62	62	62	62	62	62	62	62	62	62
F	F(8,1291) =3963.81	F(8,1291) =3963.81	F(8,1230) =871.42	F(8,61) =61.28	Wald chis(8) =11449.54	Wald chi(2) =1009.51	Wald chi2(8) =31931.52	F(69,1230) =713.26	F(12,1287) =3041.19	Wald chi(69) =52015.88	Wald chi2(12) =36862.86
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Annexure 6.1: <u>Regression results to study the impact on emission intensity of industries pre and post policy intervention</u>

Table XXIII : Regression results indicating impact on emission intensity (Lnemi) taking both PAT and ECA together for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**
	Pooled OLS (Lnemi) Robust	**Fixed Effect (Lnemi) Robust**	**Random Effect (Lnemi) Robust**	**Pooled OLS i.panelid (Lnemi)**	**Pooled OLS i.industryid (Lnemi)**	**GLS i.panelid (Lnemi)**	**GLS i.industryid (Lnemi)**
Lnei	-.4636006 (.939773)	-2.393437 (1.824493)	-2.239846 (1.785274)	-2.393437** (.9158751)	-.0550803 (.9062583)	-2.393437** (.8551666)	-.0550803 (.8954045)
Lnpmi	1.129215** (.5136941)	.4556964 (.7098864)	.568843 (.7076566)	.4556964 (.4843362)	1.639199*** (.5846808)	.4556964 (.4680969)	1.639119** (.5776784)
Lna	.0909022 (.1684586)	.6414596 (.7569762)	.3184875 (.5093831)	.6414596 (.4951746)	.3290486* (.187409)	.6414596 (.4785719)	.3290486* (.1851645)
Lnli	12.98139*** (1.832223)	3.248528 (2.171968)	3.968927* (2.195908)	3.248528* (1.731966)	13.91574*** (1.923783)	3.248528* (1.673895)	13.91574*** (1.900743)
Lnci	.7116882** (.3158539)	.5353514 (.3500247)	.5092424 (.3311277)	.5353514** (.2684497)	.70309* (.3209021)	.5353514** (.2594488)	.70309** (.3170588)
Lnri	-7.068564 (6.711594)	10.46764* (5.800345)	7.704346 (5.396371)	10.46764 (7.775462)	5.745291 (6.353097)	10.46764 (7.514757)	-.0870544* (.4146771)
Lnsi	-.2565915*** (.05	-.6882668*** (.128754)	-.5731318*** (.0902883)	-.6882668*** (.1125495)	-.0870544 (.0600252)	-.6882668*** (.1087758)	.2441753 (.5146771)
Lntmi	.76856732 (.5241875)	.9810479 (.6296362)	.989041** (.5835677)	.9810479* (.4448684)	.2441753 (.5209158)	0.9810479 ** 0.4299524	-.6355379*** (.1859069)
pat	-.5914929** (.1950967)	-.5533 (.3926337)	-.5414081 (.3787304)	-.5533*** (.1499625)	-.6355379*** (.1881604)	-0.5533*** 0.1449344	-.895828*** (.176328)
eca	-.7527454*** (.1834169)	-.405093** (.1308361)	-.395181*** (.1140331)	-.405093** (.1691487)	-.895828*** (.1784653)	-0.405093** 0.1634773	-.895828*** (.176328)
_cons	15.54597*** (.8842086)	18.36792*** (1.683891)	18.33051*** (1.305997)	15.85148*** (1.535869)	11.39556*** (1.056937)	15.85148*** (1.484373)	11.39556*** (1.044278)
Number of obs.	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26
F/ Wald chi2	F(10,535) =19.82	F(10,25) =13.26	Wald ci2(10) =188.77	F(35,510) =14.63	F(12,533) =	Wald chi2(35) =1000.62	Wald chi2(12) =179.87
Prob > F/ Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table XXIV: Regression results indicating impact on emission intensity (Lnemi) taking only PAT (Lnemi) for Dataset 1

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-IX**	**Model-X**	**Model-XI**
	Pooled OLS (Lnemi)	**Pooled OLS (Lnemi) Robust**	**Fixed Effect (Lnemi)**	**Fixed Effect (Lnemi) Robust**	**Random Effect (Lnemi)**	**Random Effect (Lnemi) Robust**	**Generalised Least Square (Lnemi)**	**Pooled OLS i.panelid (Lnemi)**	**Pooled OLS i.industryid (Lnemi)**	**GLS i.panelid (Lnemi)**	**GLS i.industryid (Lnemi)**
Lnei	-0.2420919 (0.8381281)	-0.2420919 (0.9402385)	-2.09207** (0.911383)	-2.09207 (1.79537)	-1.975623** (0.8878768)	-1.975623 (1.724848)	-0.2420919 (0.8304175)	-2.09207 (0.911383)	.3697386 (.9225139)	-2.09207** (0.8816882)	.3697386 (.9123201)
Lnpmi	0.888125 (0.6017781)	0.888125* (0.4964594)	0.3896816 (0.4857866)	0.3896816 (0.7256067)	0.4550169 (0.4795154)	0.4550169 (0.7292138)	0.888125 (0.5962418)	0.3896816 (0.4857866)	1.355085** (.5949746)	0.3896816 (0.4699587)	1.355085** (.5884)
Lna	0.0495539 (0.1734268)	0.0495539 (0.1768245)	-0.0149424 (0.414309)	-0.0149424 (0.6030976)	-0.0925327 (0.3265932)	-0.0925327 (0.4746744)	0.0495539 (0.1718313)	-0.0149424 (0.414309)	.2208752 (.1903369)	-0.0149424 (0.4008099)	.2208752 (.1882337)
Lnli	10.14586*** (1.897347)	10.14586 *** (1.797524)	1.777221 (1.626831)	1.777221 (2.130983)	2.280078 (1.585416)	2.280078 (2.164769)	10.14586 (1.879891)	1.777221 (1.626831)	10.57398*** (1.845358)	1.777221 (1.573825)	10.57398*** (1.882337)
Lnci	0.7785627** (0.3372201)	0.7785627 ** (0.3150044)	0.6048316** (0.2681111)	0.6048316* (0.350143)	0.5872811** (0.2658586)	0.5872811* (0.3304149)	0.7785627 (0.3341177)	0.6048316 (0.2681111)	.7929743 (.3275807)	0.6048316 (0.2593755)	.7929743** (.3239609)
Lnri	-6.321568 (6.29541)	-6.321568 (6.70627)	9.22261 (7.793928)	9.22261* (5.316641)	7.114078 (7.451183)	7.114078 (4.872858)	-6.321568 (6.237493)	9.22261 (7.793928)	5.980209 (6.495261)	9.22261 (7.539986)	5.980209 (.6495261)
Lnsi	-0.2736933 (0.0545958	-0.2736933*** (0.0575635)	-0.6659587*** (0.1126818)	-0.6659587*** (0.1272411)	-0.5872439*** (0.0919269)	-0.5872439*** (0.0968656)	-0.2736933 (0.0540936)	-0.6659587 (0.1126818)	-.1140548* (.0611232)	-0.6659587*** (0.1090104)	-.1140548* (.0611232)
Lntmi	0.5248181 (0.5284498	0.5248181 (0.3648989)	0.8312186* (0.4424836)	0.8312186 (0.6214626)	0.8342804** (0.4387448)	0.8342804 (0.5843136)	0.5248181 (0.5235882)	0.8312186 (0.4424836)	.0572464 (.5312242)	0.8312186** (0.4280665)	.0572464 (.5312242)
Pat	-0.8035337*** (0.1908911)	-0.8035337*** (0.251216)	-0.5123811*** (0.1496748)	-0.5123811 (0.3927725)	-0.541292*** (0.1447966)	-0.541292 (0.378985)	-0.8035337 (0.1891349)	-0.5123811 (0.1496748)	-.8721976*** (.1862391)	-0.5123811*** (0.144798)	-.8721976*** (.1862391)
-cons	15.49192 *** (0.8970815	15.49192*** (1.035091)	20.28528*** (1.229783)	20.28528*** (1.43363)	19.748*** (1.169672)	19.748*** (1.330921)	15.49192 (0.8888285)	17.78134 (1.31354)	11.64214*** (1.07945)	17.78134*** (1.270742)	11.64214*** (1.07945)
No of obs.	546	546	546	546	546	546	546	546	546	546	546
Number of groups	26	26	26	26	26	26	26	26	26	26	26
F/ Wald chi2	F(9,536) =11.17	F(9,536) =18.83	F(9,511) =13.94	F(9,25) =17.33	Wald chi2(9) =122.79	Wald chi2(9) =203.27	Wald chi2(9) =102.43	F(34,511) =27.07	F(11,534) =13.08	Wald chi2(34) =983.42	F(11,534) =13.08
Prob > F/ Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table XXV : Regression results indicating impact on emission intensity (Lnemi) taking only ECA for Dataset 1

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-IX	Model-X	Model-XI
	Pooled OLS (Lnemi)	**Pooled OLS (Lnemi) Robust**	**Fixed Effect (Lnemi)**	**Fixed Effect (Lnemi) Robust**	**Random Effect (Lnemi)**	**Random Effect (Lnemi) Robust**	**Generalised Least Square (Lnemi)**	**Pooled OLS i.panelid (Lnemi)**	**Pooled OLS i.industryid (Lnemi)**	**GLS i.panelid (Lnemi)**	**GLS i.industryid (Lnemi)**
Lnei	-0.7215764 (0.8296542)	-0.7215764 (1.014812)	-2.571276** (0.9258248)	-2.571276 (1.809181)	-2.498402** (0.8972974)	-2.498402 (1.783926)	-0.7215764 (0.8220215)	-2.571276** (.9258248)	-.2410675 (.9133572)	-2.571276** (.8956595)	-.2410675 (.9032645)
Lnpmi	1.208587** (0.5999365)	1.208587** (0.528131)	0.5980513 (0.4887191)	0.5980513 (0.7996636)	0.6816053 (0.4841849)	0.6816053 (0.7848474)	1.208587 ** (0.5944172)	.5980513 (.4887191)	1.734737** (.5896591)	.5980513 (.4727957)	1.734737** (.5831433)
Lna	0.0353144 0.1715273	0.0353144 (0.175)	-0.1099218 (0.4568955)	-0.1099218 (0.7610696)	-0.1341576 (0.3450649)	-0.1341576 (0.5363092)	0.0353144 (0.1699493)	-.1099218 (.45689955)	.2469683 (.1876291)	-.1099218 (.4420089)	.2469638 (.1855558)
Lnli	13.44629 *** (2.002699)	13.44629*** (1.897034)	3.632177** (1.750048)	3.632177 (2.334271)	4.376186* (1.729034)	4.376186* (2.296143)	13.44629*** (1.984274)	3.632177** (1.750048)	14.41406*** (1.936721)	3.632177** (1.693028)	14.41406*** (.1855558)
Lnci	0.7914681*** (0.3342264)	0.7914681 ** (0.315682)	0.6321878** (0.2704407)	0.6321878* (0.3149388)	0.610601* (0.2681688)	0.610601* (0.2884724)	0.7914681** (0.3311515)	.6321878** (.2704407)	.7938818* (.3228757)	.6321878** (.2616292)	.7938818** (.3193079)
Lnri	-6.10472 (6.246097)	-6.10472 (6.614625)	12.3722 (7.853474)	12.3722* (6.590051)	10.20642 (7.473132)	10.20642* (5.706209)	-6.10472 (6.188634)	12.3722 (.1138714)	6.790368 (6.407101)	12.3722* (7.597592)	6.790368 (6.336302)
Lnsi	-0.2719284*** (0.054139)	-0.2719284*** (0.0617421)	-0.6749458*** (0.1138714)	-0.6749458*** (0.1244628)	-0.5959386*** (0.0923437)	-0.5959386*** (0.0961256)	-0.2719284*** (0.0536409)	.6749458*** (.1138714)	-.1026358* (.0604282)	-.6749458*** (.1101612)	-.1026358* (.0597604)
Lntmi	0.7287958 (0.5280116)	0.7287958* (0.3995959)	0.8416755* (0.448699)	0.8416755 (0.5891464)	0.8625133* (0.4448354)	0.8625133 (0.554194)	0.7287958 (0.523154)	.8416755** (.448699)	.2345331 (.5259601)	.84167555* (.4340794)	.2345331 (.5201482)
Eca	-0.9000106*** (0.1782147)	-0.9000106*** (0.1655767)	-0.3339878** (0.1701086)	-0.3339878** (0.1457463)	-0.3959963** (0.1565438)	-0.3959963*** (0.1189028)	-0.9000106 *** (0.1765751)	-.3339878** (.1701086)	-1.046868*** (.1744478)	-.3339878** (.1645661)	-1.046868*** (.1725201)
_cons	15.8647*** (0.8846202)	15.8647*** (1.099445)	20.77349*** (1.325395)	20.77349*** (2.081191)	20.06971*** (1.215596)	20.06971*** (1.751268)	15.8647*** 0.8764818	18.25839*** (1.407499)	11.78066*** (1.06096)	18.25839*** (1.361639)	11.78066*** (1.049237)
No of obs.	546	546	546	546	546	546	546	546	546	546	546
No of groups	26	26	26	26	26	26	26	26	26	26	26
F/ Wald chi2	Wald chi2(11) =147.11	F(9,536)= 21,63	F(9,511) =12.88	F(9,25) =11.65	Wald chi2(9) =113.58	Wald chi(9) =148.97	Wald chi2(9) =111.54	F(34,511) =26.44	F(11,534) =14.64	Wald chi2(34) =960.41	Wald chi2(11) =164.66
Prob > F/ Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table XXVI : Regression results indicating impact on emission intensity (Lnemi) taking both PAT and ECA for Dataset 2

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII
	Pooled OLS (Lnemi) Robust	**Fixed Effect (Lnemi) Robust**	**Random Effect (Lnemi) Robust**	**Pooled OLS i.panelid (Lnemi)**	**Pooled OLS i.industryid (Lnemi)**	**GLS i.panelid (Lnemi)**	**GLS i.industryid (Lnemi)**
Lnei	-.4036376 (.2614669)	-.7559386 (.5580371)	-.5544198 (.3866684)	-.7559386** (.3043605)	-.6651853*** (.2142269)	-.7559386** (.2956965)	-.6651853*** (212856.3)
Lnpmi	-.1396546 (.2600024)	-.1929141 (.1625844)	-.4640231 (.6505782)	-.1929141** (.9568414)	-.1130422 (.9405108)	-.19291411** (.9296036)	-.1130422 (.9344934)
Lna	-.2267779 (.1438137)	-.8022368 (.6973903)	-.3092043 (.2326828)	-.8022368*** (.9632966)	-.2497114*** (.3367578)	-.8022368*** (.935875)	-.2497114*** (.3346032)
Lnli	.9880712 (.6424925)	.1702864 (.4979145)	.8760643 (.8239741)	.1702864 (.530818)	.1042172** (.4359424)	.1702864 (.5157075)	.1042172** (.4331532)
Lnci	-.1080787 (.7366544)	-.2295939 (.2748044)	-.1318309 (.1572245)	-.2295939** (.7117897)	-.1074597* (.6438883)	-.2295939** (.6915276)	-.1074597* (.6397687)
Lnri	.6082043 (.5827731)	-.469335 (.1003293)	.6626144 (.1348379)	-.469335 (.1478181)	.5398837 (.1137020)	-.469335 (.1436102)	.5398837 (.1129746)
Lnsi	-.7688742 (.4878434)	-.1812368** (.87946)	-.1217505 (.8452153)	-.1812368*** (.1930549)	-.7512511*** (.1056497)	-.1812368*** (.1875593)	-.7512511 (.1049737)
Lntmi	-.601902 (.5202717)	-.1717151 (.1552211)	-.628237 (.1151816)	-.1717151 (.1410988)	.7615662** (.1211996)	-.1717151 (.1370822)	.7615662 (.1204242)
pat	.6234178 (.408402)	.2217543 (.1513419)	.9580593 (.7300961)	.2217543*** (.3834471)	.6313927 (.3915947)	.2217543*** (.3725317)	.6313927 (.3890893)
eca	.6007452 (.1317684)	.2442949 (.1732413)	.5468021 (.4126942)	.2442949*** (.4011806)	.7236111 (.3556328)	.2442949*** (.3897604)	.7236111 (.3533574)
-cons	.1659246 (.1042459)	.4773479 (.2919658)	.2415501 (.1719169)	.4958331*** (.3130919)	.1807367*** (.1485053)	.4958331*** (.3041793)	.1807367 (.1475551)
Number of obs.	1176	1176	1176	1176	1176	1176	1176
Number of groups	56	56	56	56	56	56	56
F/ Wald chi2	F(10,1165) =0.25	F(10,55) =1.12	Wald chi2(10) =4.39	F(65,1110) =8.37	F(14,1161) =12.08	Wald chi2(65) =576.71	Wald chi2(14) =171.35
Prob > F/ Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table XXVII: Regression results indicating impact on emission intensity (Lnemi) taking only PAT (Lnemi) for Dataset 2

	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-IX	Model-X	Model-XI
	Pooled OLS (Lnemi)	**Pooled OLS (Lnemi) Robust**	**Fixed Effect (Lnemi)**	**Fixed Effect (Lnemi) Robust**	**Random Effect (Lnemi)**	**Random Effect (Lnemi) Robust**	**Generalised Least Square (Lnemi)**	**Pooled OLS i.panelid (Lnemi)**	**Pooled OLS i.industryid (Lnemi)**	**GLS i.panelid (Lnemi)**	**GLS i.industryid (Lnemi)**
Lnei	-.4041122** (.1597004)	-.4041122 (.2616103)	-.8743333** (.3086316)	-.8743333 (.6322094)	-.5633976** (.2055259)	-.5633976 (.392365)	-.4041122* (.1590199)	-.8743333** (.3086316)	-.6658096*** (.2141166)	-.8743333*** (.299981)	-.6658096*** (.2128383)
Lnpmi	-.130393 (.8549296)	-.130393 (.2550935)	-.1142917 (.9633624)	-.1142917 (.1216569)	-.333113 (.9082216)	-.333113 (.5864237)	-.130393 (.8512869)	-.1142917 (.9633624)	-.971115 (.9368596)	-.1142917 (.9363604)	-.971115 (.9312663)
Lna	-.225982*** (.3026381)	-.225982 (.1431963)	-.4799424*** (.8178329)	-.4799424 (.4674666)	-.2902653*** (.4072852)	-.2902653 (.2218937)	-.225982*** (.3013486)	-.4799424*** (.8178329)	-.2485553*** (.3317929)	-.4799424*** (.79491)	-.2485553*** (.329812)
Lnli	.9992441** (.4159086)	.9992441 (.6497811)	.8265007 (.5281367)	.8265007 (.8834542)	.1019083** (.467303)	.1019083 (.9008956)	.9992441* (.4141365)	.8265007 (.5281367)	.1056279** (.4302168)	.8265007*** (.5133336)	.1056279** (.4276484)
Lnci	-.109026** (.5984631)	-.109026 (.7423842)	-.2338679*** (.7232202)	-.2338679 (.2837774)	-.1391967** (.6566915)	-.1391967 (.1617295)	-.109026* (.5959132)	-.2338679*** (.7232202)	-.1083419* (.6421619)	-.2338679 (.7029492)	-.1083419* (.638328)
Lnri	.5858978 (.1125023)	.5858978 (.5696356)	-.1365458 (.1494530)	-.1365458 (.1141792)	.4182003 (.1297303)	.4182003 (.1256065)	.5858978 (.1120230)	-.1365458 (.1494530)	.5141424 (.1129494)	-.1365458*** (.1452640)	.5141424 (.1122751)
Lnsi	-.7669555 *** (.1001626)	-.7669555 (.486464)	-.1964653*** (.1945118)	-.1964653** (.9813979)	-.1181795*** (.1249198)	-.1181795 (.8261028)	-.7669555*** (.997358)	-.1964653*** (.1945118)	-.7492713*** (.1051573)	-.1964653*** (.1890599)	-.7492713*** (.1045294)
Lntmi	-.6061058 (.1191756)	-.6061058 (.5177823)	-.1478321 (.1433162)	-.1478321 (.1383261)	-.5839367 (.1307634)	-.5839367 (.1085605)	-.6061058 (.1186678)	-.1478321 (.1433162)	.7482409 (.1211479)	-.1478321 (.1392992)	.7482409 (.1204246)
Pat	.6399574* (.3786744)	.6399574 (.4179785)	.209347*** (.3890733)	.209347 (.1457489)	.1056329** (.3706667)	.1056329 (.8011161)	.6399574* (.377061)	.209347*** (.3890733)	.6509332* (.3794795)	.209347*** (.378168)	.6509332* (.3772139)
_cons	.1658703*** (.1290027)	.1658703 (.1041689)	.3944048*** (.2438865)	.3944048 (.2460301)	.2348915** (.1639834)	.2348915 (.1688480)	.1658703*** (.1284531)	.4079474*** (.2823184)	.1806122*** (.1483181)	.4079474*** (.2744053)	.1806122*** (.1474326)
No of obs.	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176
Number of groups	56	56	56	56	56	56	56	56	56	56	56
F/ Wald chi2	F(9,1166) =18.19	F(9,1166) =0.28	F(9,1111) =37.92	F(9,55) =1.05	Wald chi2(9) =214.27	Wald chi2(9) =4.28	Wald chi2(9) =165.16	F(64,1111) =7.68	F(13,1162) =13.02	Wald chi2(64) =520.05	Wald chi2(13) =171.30
Prob > F/ Prob > chi2	0.0000	0.9794	0.0000	0.4131	0.0000	0.8919	0.0000	0.0000	0.0000	0.0000	0.0000

Table XXVIII : Regression results indicating impact on emission intensity (Lnemi) taking only ECA (Lnemi) for Dataset 2

	Model-I	**Model-II**	**Model-III**	**Model-IV**	**Model-V**	**Model-VI**	**Model-VII**	**Model-VIII**	**Model-IX**	**Model-X**	**Model-XI**
	Pooled OLS (Lnemi)	**Pooled OLS (Lnemi) Robust**	**Fixed Effect (Lnemi)**	**Fixed Effect (Lnemi) Robust**	**Random Effect (Lnemi)**	**Random Effect (Lnemi) Robust**	**Generalised Least Square (Lnemi)**	**Pooled OLS i.panelid (Lnemi)**	**Pooled OLS i.industryid (Lnemi)**	**GLS i.panelid (Lnemi)**	**GLS i.industryid (Lnemi)**
Lnei	-.4150064** (.1597375)	-.4150064 (.2684994)	-.882310 (.3079759)	-.882310*** (.6180536)	-.579930*** (.2058922)	-.579930 (.4079772)	-.4150064** (.1590569)	-.882310** (.3079759)	-.6822918*** (.2141113)	-.882310*** (.2993437)	-.6822918*** (.212833)
Lnpmi	-.2594629 (.8542886)	-.2594629 (.2877736)	-.220681 (.9694896)	-.220681** (.1857649)	-.6486144 (.9097379)	-.6486144 (.7493397)	-.2594629 (.8506486)	-.220681* (.9694896)	-.2423165 (.9377319)	-.220681** (.9423159)	-.2423165 (.9321334)
Lna	-.2213299*** (.3046709)	-.2213299 (.1406466)	-.5947093 (.9069222)	-.5947093*** (.5488583)	-.2885792*** (.4156705)	-.2885792 (.2192864)	-.2213299*** (.3033727)	-.5947093*** (.9069222)	-.243804*** (.3349891)	-.5947093*** (.8815022)	-.243804*** (.3329892)
Lnli	.1002083** (.4214554)	.1002083 (.6520132)	.2896821 (.5381057)	.2896821 (.5637424)	.9153295** (.4767854)	.9153295 (.8560242)	.1002083** (.4196597)	.2896821 (.5381057)	.1050527** (.4362116)	.2896821 (.5230232)	.1050527** (.4336073)
Lnci	-.1060808** (.6015807)	-.1060808 (.725705)	-.2084747 (.7211573)	-.2084747*** (.261841)	-.1273829** (.6601577)	-.1273829 (.1531599)	-.1060808* (.5990175)	-.2084747*** (.7211573)	-.1060564 (.6442725)	-.2084747*** (.7009441)	-.1060564* (.6404261)
Lnri	.6130486 (.1133901)	.6130486 (.5768308)	-.2195995 (.1498970)	-.2195995 (.1149695)	.6983923 (.1310639)	.6983923 (.1335875)	.6130486 (.1129070)	-.2195995 (.1498970)	.5536752 (.1137771)	-.2195995 (.1456955)	.5536752 (.1130978)
Lnsi	-.7615426*** (.1008029)	-.7615426 (.4838458)	-.1905563 (.19517)	-.1905563*** (.9580243)	-.1187119*** (.1257936)	-.1187119 (.8339936)	-.7615426*** (.1003734)	-.1905563*** (.19517)	-.7427737*** (10559.14)	-.1905563*** (.1896996)	-.7427737*** (.104961)
Lntmi	.2502716 (.1191841)	.2502716 (.4864907)	-.1156743 (.1428062)	-.1156743 (.1334754)	-.4236422 (.1308145)	-.4236422 (.1021212)	.2502716 (.1186763)	-.1156743 (.1428062)	.175744 (.1211254)	-.1156743 (.1388035)	.175744 (.1204023)
eca	.2009154 (.3433921)	.2009154*** (.1767727)	.2319666 (.4064214)	.2319666*** (.1664121)	.7027497* (.3462189)	.7027497 (.5266943)	.2009154 (.3419289)	.2319666*** (.4064214)	.2129854 (.3450096)	.2319666*** (.3950299)	.2129854 (.3429499)
_cons	.1633178 (.1281403)	.1633178 (.1027701)	.4165741 (2588841)	.4165741*** (.2594768)	.2314454*** (.1636409)	.2314454 (.1665373)	.1633178*** (.1275943)	-.882310*** (.3079759)	.1780671*** (.147681)	.4326726*** (.2893361)	.1780871*** (.1467993)
No of obs.	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176	1176
Number of groups	56	56	56	56	56	56	56	56	56	56	56
F/ Wald chi2	F(9,1166) =17.88	F(9,1166) =0.28	F(9,1111) =38.43	F(9,55) =1.00	Wald chi(2) =209.74	Wald chi2(9) =2.0.74	Wald chi2(9) =162.17	F(64,1111) =7.76	F(13,1162) =12.79	Wald chi2(64) =525.44	Wald chi2(13) =168.34
Prob > F/ Prob > chi2	0.0000	0.0000	0.0000	0.4514	0.0000	0.	0.0000	0.0000	0.0000	0.0000	0.0000