

CAUSAL RELATIONSHIP BETWEEN THE PERFORMANCE OF MANUFACTURING AND ENERGY SECTOR: CURRENT SCENARIO OF INDIAN ECONOMY

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Abstract *Economic development has often been associated with the performance of the manufacturing sector. Current slowdown of Indian manufacturing has been the centre of economic debate. This paper dwells into the complexities of the Indian manufacturing sector highlighting its relation with the power sector. The study emphasizes that sluggish performance of manufacturing is attributed to the retarded growth of Indian power. Due to the insufficient energy resources, growth of Indian manufacturing has faced tremendous challenges. The study recommends that higher productivity in the power sector through lowering transmission losses and increasing investment in renewable sources may act as a stimulus for both Indian power and manufacturing sector.*

Keywords: *Indian Manufacturing, Indian Power, Causal Relationship*

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INTRODUCTION

The causal relationship between energy consumption and GDP output or income is a well-studied topic in the literature of energy economics. The causality is in the sense of Granger causality test (introduced by Granger, 1969) portrayed a unidirectional causality running from GNP to energy consumption for the United States (Kraft and Kraft 1978). However, different results for different countries as well as for different time periods within the same country were pointed out by economists like Akarca and Long (1980). In most recent studies like those put forward by Yu and Jin (1992); Masih and Masih (1996, 1997); Glasure and Lee (1997), researchers have focused on the co-integrating relationship between energy consumption/output among some of the fast developing economies like India and China.

Economists have time and again focused their research in establishing the relationship between energy and

manufacturing sector. This is because the performance of energy sector has often been associated with the performance of the manufacturing sector. The sudden dip in the Indian GDP growth rate in the mid 2011 to nearly 6 percent triggered serious thought process among the Indian manufacturers and Government. This current slowdown of Indian manufacturing has now become the centre of economic debate. This paper dwells deeper into the complexities of the Indian manufacturing sector highlighting its relation with the power sector. The study emphasises that sluggish performance of manufacturing is attributed to the retarded growth of Indian power. Due to the insufficient energy resources, growth of Indian manufacturing has faced tremendous challenges. The next section details the various literature reviews that have been put forward over the years to establish the relation between the development of manufacturing sector and performance of power industry. The subsequent section details the performance of Indian manufacturing sector over the past few years indicating that the growth of the sector has been largely stagnant or even diminishing. The latter section then discusses the performance of Indian energy sector and link its performance to that of manufacturing sector. The study finds that the sluggishness in the power sector has been one of the major causes for the slow GDP growth which is being experienced by India. Finally in the last section the study recommends that higher productivity in the power

sector through lowering transmission losses and increasing investment in renewable sources may act as a stimulus for both: India power and manufacturing sector.

LITERATURE REVIEW

In energy economics literature, there is wide range of studies which deal with establishing the relationship between energy consumption and economic growth, the demand for energy in households, demand for energy in industries, and establishing the relationship between energy consumption and climate change. Energy has been universally recognized as one of the most important inputs for economic growth and human development. Earlier studies have found a strong two-way relationship between economic development and energy consumption (Dhungel, 2008). However, energy consumption in developing countries increased more than fourfold over the past three decades and is expected to increase rapidly (IEA, 2007). Number of factors influence energy requirement of an economy, where economic growth is one of the most important factors. Economic growth is often accompanied by industrialization, electrification, and rapid growth of infrastructure. Economic growth tends to be directly correlated with increased energy consumption, at least to a certain point. Beyond a certain point however, further economic development actually can lead to structural shifts in the economy that reduce the prominence of energy consumption of an economy as higher income levels can lead to the development and diffusion of more technologically sophisticated and less energy intensive machines.

The energy mix in India has shifted towards coal, due to higher endowment of coal relative to oil and gas, which has led to a rapidly rising trend of energy emissions intensities (IEA, 2007). The energy intensity of India is over twice that of the matured economies, which are represented by the OECD member countries (IEA, 2007). However, since 1999, India's energy intensity has been decreasing and is expected to decrease (Planning Commission, Govt. of India, 2001). As per (CEA, 2003) The decline in energy intensity in the Indian economy could be attributed to several factors; some of them being demographic shifts from rural to urban areas, structural economic changes towards less energy intensive industries, impressive growth of services, improvement in efficiency of energy use, and inter-fuel substitution.

Studies have been conducted in total factor productivity (TFP) and technical efficiency in Indian manufacturing industries (Mitra et al. 1998; Goldar, 2004). Studies have also focused on TFP of energy intensive industries in Indian manufacturing industries (Mongia and Sathaye, 1998). For example, Nguyen-Van (2008) has tried to find out the relationship between energy consumption and economic growth. The findings suggest that energy consumption in developing countries would rise more rapidly than

expected. Further, the result suggests that there will be serious challenges to economic and environmental problems in developing countries such as rapid augmentation of greenhouse gas emission due to energy use, excessive pressure on the provision of energy resources, etc. In addition, the study also depicts rapid increase in fossil fuel use in developing countries; also represent a growing contribution to the increase in local and regional air pollution as well as atmospheric concentrations of greenhouse gases such as carbon dioxide (CO₂) which motivates us to move towards the non-renewable sources of energy as depicted in our report.

Using generalized Leontief functional form, Andersen et al. (1998) obtained price elasticity at -0.26 for the manufacturing sectors energy demand and the aggregate elasticity for various industrial sub-sectors ranging between -0.10 and -0.35. For example Mongia et al. (2001) reviewed the policy reforms and the productivity change in energy intensive industries in India. Using four inputs (KLEM4) model they have employed decomposition analysis of output growth and the residual representing the total factor productivity. They found that the overall productivity growth of energy intensive industries have gone down from 1973-1994; however, there is a significant difference in productivity growth across industries in India. Finding of this study implies that role of energy is an important input for output especially for the Indian energy intensive sector. The Berkeley lab on the energy studies have also analyzed the change in the total factor productivity in Indian manufacturing and found similar results for the select energy intensive industries and thereby have been an important source of our report. Hence, from the policy makers and researchers point of view, there is a need to understand the parameters of energy efficiency of firms.

Recently there are very few studies those focus on the energy intensity analysis at the firm level also. In the comparative context, recent study by Vanden and Quan (2002) for China is relevant. They employed approximately 2,500 large and medium-sized industrial enterprises in China from 1997-1999 to identify the factors driving the fall in total energy use and energy intensity. Using an econometric approach, that identifies sources of variation in energy intensity they found that changing energy prices and research and development expenditures are significant drivers of declining energy intensity whereas changes in ownership, region, and industry composition are less important. In addition, the impact of R&D spending on energy intensity suggested that firms are using resources for energy saving innovations for the Chinese enterprises.

In an earlier attempt Sahu and Narayanan (2011) studied the determinants of energy intensity of Indian manufacturing for cross sectional data of 2007. Using an econometric approach the study identified variation in energy intensity. The analysis

Table 1: Share of Different Sectors in Indian Real GDP

Sector	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12 (estimated rates)
Agriculture	6.3	-7.2	10	1.6	5.1	4.2	5.8	0.1	1	7	2.5
Services	7.2	7.5	8.5	9.4	10.9	10.1	10.3	10	10.5	9.3	9.4
Industry	2.7	7.1	7.4	9.4	9.7	12.2	9.7	4.4	8.4	6.2	3.9

Source: Usha Sagar, Manufacturing Sector Contribution to GDP, 2012

brings out the conclusion that ownership type is also an important determinant of energy intensity and foreign owned firms exhibit higher level of technical efficiency and hence less energy intensive. Further, the results of the study reveal that R&D activities are important contributors in reducing firm level energy intensity. The study also identified that there is a sizable difference in energy intensity between higher energy intensive and less energy intensive firms.

Based on the review of literature the objective of this work is to determine the causal relationship between the performance of the manufacturing and energy sector in India reviewing the energy production stats and the consumption patterns in the manufacturing sector with various factors like transmission losses, R&D kept in mind.

TRENDS IN INDIAN MANUFACTURING SECTOR

Manufacturing can be defined as physical and/or chemical transformation of materials into products on a large scale using machinery or capital equipment, in contrast to production of hand-made goods for personal use. The products provide utility or satisfaction to members of the society. They may take the form of final consumption goods, semi-finished goods: parts and raw materials or capital goods: used for making final products (Manufacturing for wealth creation, 2010)

Manufacturing industry is the engine of economic growth of a nation. It includes all activities in product life, starting from customer inputs for concept design, through conversion of materials and ending with product disposal. These activities provide gainful employment, create the products required to maintain and improve the standard of living and generate the wealth required for future development (B. Ravi et. Al., July 2003).

The manufacturing industry in India has all the qualities which can enhance its economic development. By increasing the productivity of the manufacturing industry, India can become a leading economy in manufacturing sector across

global markets. The manufacturing industry in India is believed to have the potential of improving the economic condition of India. The Indian economy witnessed an impressive growth rate of over 8.5 percent during 2004-05 to 2006-07, primarily on the back of robust growth in the manufacturing and services sector (Kumar R et. Al., 2008). The manufacturing sector expanded at a remarkable growth rate of 12.3 percent during 2006-07. These figures were significantly higher than the average annual growth of 5.7 percent that were observed in the previous five years. These figures clearly establish that the performance of Indian manufacturing has been degrading over the years.

Since India is eyed as one of the fastest emerging economies, various economists assert that a sustained double digit growth of the manufacturing sector is essential for achieving the desired GDP growth of 8 to 9 percent (Kumar R et. Al., 2008). Given, India's stage of development, manufacturing is considered to be the engine of growth and development. Apparently this is not happening as the growth has been primarily driven by services. In fact, Kochhar et. al. (2006) point out that the change in the share of manufacturing in GDP in India between 1980 and 2000 has been 2.5 percentage points lower than the average country at the same stage of development, while the change in service share was 10 percentage points higher than average. Table 1 shows the share of different sectors in Indian real GDP clearing the picture of the performance.

Having established the trend of Indian manufacturing it's safe to assert that the production in Indian manufacturing has been declining. The GDP of around 6 percent accounted in the Indian economy during 2011 has commenced series of discussion among economists regarding the growth path of the Indian economy. Economists believe that this downfall in the Indian manufacturing is partly attributed to its relation with the power sector- whose real growth has been dwindling over the years. The next section elaborates this relation between the two sectors and suggests key remedies that may enhance the overall generation of power in Indian thereby aiding manufacturing growth.

RELATION BETWEEN INDIAN ENERGY AND MANUFACTURING SECTORS

An efficient power system is a key requirement for a nation's economic growth and good quality life of its citizens. Assured availability of quality power at a reasonable cost will not only act as a catalyst in the socio-economic development of the country, but also enhance the global competitiveness of the industrial sector. Talking about the Indian energy sector The total installed capacity for electricity generation in the country has increased from 16,271 MW as on 31.03.1971 to 1, 87,872 MW as on 31.03.2010, registering a compound annual growth rate (CAGR) of 6.1%. (IEA 2010) The electricity sector in India had an installed capacity of 199.87 Gigawatt (GW) as of March 2012, the world's fifth largest. Thermal power plants constitute 66% of the installed capacity, hydroelectric about 19% and rest being a combination of wind, small hydro, biomass, waste-to-electricity, and nuclear. India generated 855 BU electricity during 2011-12 fiscal years (CEA 2011). This increasing trend of production in the power sector is not being supported by reducing the transmission losses in the power grids. Table 2 depicts the rising transmission losses due to the rising productions of electricity.

Table 2: The Rising Transmission Losses in Indian Power Sector

YEAR	TRANSMISSION LOSS (%)
1970	16.36
1980	17.88
1990	19.53
2000	27.63
2010	24.45

Source: CEA, 2010

Transmission mechanism basically refers to the supply of electricity from power stations to the various required points such as the power houses of the state and central electricity board. The losses that take place during the transmission of electricity are referred to as transmission losses. Electric power transmission and distribution losses include losses in transmission between sources of supply and points of distribution and in the distribution to consumers, including pilferage. Transmission losses in India are as high as the amount of electricity can be used to run two large metropolitan cities like Mumbai. The electric power transmission and distribution loss (kWh) in India was 219866.00 in 2009, according to a World Bank report, published in 2010. The electric power transmission and distribution losses (kWh) in India were reported at 180322.00 in 2008, according to the World Bank.

Moving forward economists assert that there exists a causal relationship between the power and the manufacturing sector. This section develops on this tenet by putting light on the relative demand of power in the manufacturing sector. Over 2010–11 India's industrial demand accounted for 35% of electrical power requirement, domestic household use accounted for 28%, agriculture 21%, commercial 9%, public lighting and other miscellaneous applications accounted for the rest (CEA 2011). This clearly shows the demand for electricity is highest in the industrial sector than others sectors in the economy. Therefore it is safe to assert that there exist a direct relation between the performance of the industrial and the energy sector. The poor performance of the power sector in terms of the transmission losses has been causing a hindrance in the performance of the industrial sector thereby affecting the economic growth as well. The indicator of energy–GDP (gross domestic product) elasticity, that is, the ratio of growth rate of energy to the growth rate GDP, captures both the structure of the economy as well as the efficiency (NTPC 2010). It will also lead to enhanced employment generation and per capita income levels. Rapid development of a robust and healthy domestic electrical equipment (EE) industry, supporting the complete value chain in power generation, transmission and distribution, is not only crucial for the economy, but is also of strategic importance for India. The Indian EE industry, which comprises around 90% SMEs, has grown close to 110,000 Cr in 2010-11. The industry has a diversified, mature, and established manufacturing base, which has the potential to meet the current as well as future domestic and export demands (McKinsey & Company, 2010).

Table 3: Rise in Power Consumption of Indian Manufacturing Sector 1970-2010

YEAR	CONSUMPTION (KWpH)
1970	29,579
1975	37,568
1980	48,069
1985	66,980
1990	84,209
1995	1,04,693
2000	1,07,622
2005	1,51,557
2010	2,36,752

Source: IEA, 2010

Even though the production of power/energy has been showing positive signs in the Indian power industry, the power being supplied to industrial sector (after accounting for transmission losses) has been falling. India's transmission losses are approx. 27% of the entire production. This is a

huge loss. The smart grid vision is responsive to the need. Losses remain high and the industry continues to struggle with the service quality and reliability in urban areas and electrification in rural areas. Climate change and a carbon crisis of global proportions have added to the urgency of finding a sustainable, high-growth low carbon economic model.

Investments in the renewable sources of energy are required to meet the growing energy demands. Our country India is blessed with abundance of sunlight, water and biomass. So Investments in the solar, wind, geothermal are important. As per the MNRE report India has a net potential of approx. 45000 Mw in wind and approx. For solar the grid connected capacity in the country now stands at 481.48 MW, while the total solar energy potential has been estimated at 50,000 MW. Geothermal source of energy is also an another source of renewable source of energy. Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Biomass energy can be a hit in India as India being an agricultural based country has a huge stock of the biomass being collected every year which if utilised in a sustainable manner can be very fruitful. As per IREDA (Indian renewable energy development authority) India has a biomass availability of 150 million MT per annum which gives us potential to install 16,000 MW of biomass based power plants. But only 600 MW is installed and another 600 MW is under implementation. To realize this huge potential we need an investment of Rs 1,00,000 crore. Hydro power is one of the best utilisation of the river network of our country. Hydropower is a renewable energy resource because it uses the Earth's water cycle to generate electricity. The movement of water as it flows downstream creates kinetic energy that can be converted into electricity. As per CEA, out of the total power generation installed capacity in India of 1, 76,990 MW (June, 2011), hydro power contributes about 21.5% i.e. 38,106 MW. India is blessed with immense amount of hydro-electric potential and ranks 5th in terms of exploitable hydro-potential on global scenario. As per assessment made by CEA, India is endowed with economically exploitable hydro-power potential to the tune of 1 48 700 MW of installed capacity.

Nuclear energy must also be taken into concern as it has the highest outcome of the investments made initially. India has 17 pressurized heavy water reactors (PHWRs) and two boiling water reactors (BWRs) in operation. The two BWRs commissioned in 1969 were the first nuclear power plants in Asia. The total installed capacity of nuclear power

plants stands at 4.540 GW, which contributes about 3% of total installed power capacity. Another 2.720 GW is under construction, and contracts with Russia have been signed for four LWRs of 1 GW each (Ramesh, 2009). In 2007 to 2008, the total electricity generated from nuclear sources was 16.9 TWh. India's nuclear reactors are operating at just 45% to 55% of capacity, due to a shortage of uranium.

Table 4: Figures Indicating the Hydro Power Capacity of India

INSTALLED CAPACITY (MW)	
Indus Basin	33,832
Ganga Basin	20,711
Central Indian River system	4,152
Western Flowing Rivers of southern India	9,430
Eastern Flowing Rivers of southern India	14,511
Brahmaputra Basin	66,065
Total	1,48,701

Source: Ramesh, 2009.

Therefore all the above explained methods of capitalising on India's other resources for energy production and conservation may have a positive effect not only on Indian energy but also manufacturing sector. The state should therefore make note of all these factors and work towards developing a comprehensive power industry which through its forward and backward linkages will alter the production of the manufacturing sector.

CONCLUSION

The world is facing serious challenges in energy. The global economy is set to grow threefold in the next 30 years, which promises economic benefits and huge improvements in people's standard of living. But it also implies a much greater use of energy. A global revolution is needed in the ways that energy is produced, supplied and used. A core requirement is far greater energy efficiency, which will necessitate unprecedented levels of co-operation among all states across India. India needs to investigate the mix of technologies needed to achieve deep CO₂ emission cuts in the Indian power sector while keeping pace with the strong growth in energy requirements of the manufacturing sector.

Social and economic development in India both depend on access to modern forms of energy. Around 404 million people in India do not have access to electricity. Providing electricity to these people while moving to low-carbon electricity generation is a social imperative. Indian electricity supply and demand are projected to increase fivefold to three fold between now and 2030. This development will require massive investment, but it also creates unique opportunities.

The analysis shows that India will face significant challenges in achieving power generation while also meeting the predicted growth in demand and supply. Achieving success will mean tackling a number of issues simultaneously, including a geographically uneven distribution of natural resources, financial constraints and high system losses. Accelerated exploitation of natural resources and more transmission and distribution (T&D) capacity are essential to overcome the current problems. Increased competition, additional equipment supply capacity and other actions to involve the private sector can help to accelerate investments. The various factors (like population) depicted in the Indian census clearly predict the rise in the electricity demand of the economy. The potential technology transition to achieve this expanded capacity is based on a number of technical and non-technical elements. The technical challenges of the electricity sector in India include low efficiency of thermal power plants, continued reliance on coal plants, inadequate transmission and distribution networks.

All these factors of energy conservation and production are of crucial importance for an emerging economy like India. Development of a sound energy sector with sufficient energy supply forms the basis for development of Indian manufacturing. The use of alternate resources like solar energy etc should be emphasised by the Indian State and should form the heart of policy actions if India wants to continue on the path of economic growth in the years to come.

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