

A STUDY ON IMPORT OF COAL & CRUDE OIL AND ITS IMPACT ON THE INDIAN ECONOMY

*A project report submitted in partial fulfilment of the requirement for the award of the
degree of*

MASTER OF BUSINESS ADMINISTRATION

in

INTERNATIONAL TRANSPORTATION AND LOGISTICS MANAGEMENT

by

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DECLARATION

I, **Shalini Shankar (Registration No.: 1903305031)** student of School of Maritime Management of **Indian Maritime University**, declare that this project report titled "**A STUDY ON IMPORT OF COAL & CRUDE OIL AND ITS IMPACT ON THE INDIAN ECONOMY**" is a bonafide record of work carried out by me under the supervision of **Dr. M SEKAR**, Assistant Professor, School of Maritime Management submitted in partial fulfilment of the requirements for the award of the degree of **Master of Business Administration in International Transportation and Logistics Management**. The information submitted is true and original to the best of my knowledge.



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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION AND MEANING

In a country and that is in its developing phase, like India, power and energy production is a crucial indicator of economic growth and economic development and moreover helps determine the welfare of citizens of the nation. The Energy and Power sector of India is diverse in terms of its sources ranging from the conventional fossil fuels like crude oil, coal, natural gas to renewable resources like solar, hydro, wind and even nuclear. We, as a country have a population of 1.36 billion as of 2021 and is expected to reach 1.52 billion by 2036, by then being the most populous country. As our population expands so do the requirements of power generation and transportation demands.

The government heavily relied on coal production to meet and satisfy the demand for energy of the country. Coal dominated and was primary energy source of consumption in the country in 2013. Over 75 percent of the nation's energy supply was from coal in 2019. According to the Central Electricity Authority, despite the claim renewable sources of energy are expected to generate half of India's power by 2030, the remaining half was albeit expected to be generated through coal itself. Crude oil and related products as fuels are also extensively used, but unlike coal, the significance of these fossil fuels was witnessed in the transportation sector rather than energy production for electricity.

Both coal and crude oil are natural resources which India has reserves of. India has nearly 326.49 billion metric tons of coal reserves mainly located

in which makes it stand at 5th position when considered internationally with other countries of the world. In case of crude oil, as of 2019 India has estimated its crude oil reserves to be of 618.95 million metric tons. India's reserves and production does not suffice to meet its demand requirement and hence extensively in import of coal and crude oil to meet the same.

Imports of these commodities are of concern due to the extensive quantities pumped into it, the variation in prices influencing the market along with exchange currency fluctuation. Risks to the environment and considerations required for transportation and processing are also a rising risk factor due to already persisting and climatic change concerns that the world is yet to face. Countries like India need to focus on renewable resources to keep the economic growth and development going high, however not at the cost of the environment. A healthy balance is required.

This project is a dedicated study that focusses on studying the import of coal and crude oil, its trend and how the imports of these natural exhaustible resources, how its trade has fared and will impact the economy of India.

1.2 OBJECTIVES OF THE STUDY

- To study the impact of the import of coal and crude oil on the economy of India. To study the import of coal and its trend
- To study the import of crude oil and its trend
- To study the impact of the import of coal and crude oil on Fiscal Deficit
- To suggest findings from the above study

1.3 SCOPE OF THE STUDY

The scope of the study in its entirety is based out of the Indian context. The import sector of India is vast and has its effects on the economy. For any nation it is crucial to have a trade balance for economic development and growth. The study involves to focus on two particular import commodities – coal and crude oil, which are vital for a developing nation like India that is indulging in industrialization, bettering transportation and logistics and heavy reliance on energy to cater to the development projects as well as the increasing population. For the purpose of the study data collected of the past 10 years from 2010-11 to 2019-20, from secondary sources has been used. Data regarding the import of coal and crude oil in terms of value and quantity have been obtained from the Ministry of Coal, Government of India and Petroleum Planning and Control, Ministry of Petroleum and Natural Gas, Government of India. For analysing the impact on the economy, the metrics taken into consideration was Fiscal deficit of India from the Reserve Bank of India's Data base of Indian Economy also known as RBI's Data Warehouse. The relation between these data obtained is analysed to finally arrive at the conclusion of how the imports affect the Indian economy. Together, this forms the scope of the study.

1.4 RESEARCH METHODOLOGY

Research methodology is basically the approach chosen that describes the techniques, procedures or processes utilized into the study in qualitative or quantitative basis. For the study quantitative data was required for the analysis. The data collection for the project was from official sites of the relevant departments and ministries under the Government of India and thereby secondary data. Data regarding the import of coal has been obtained from the Ministry of Coal, data regarding import of crude oil from Petroleum Planning and Control, Ministry of Petroleum and Natural Gas and data regarding fiscal deficit of India were obtained from the RBI's Data

Warehouse. The research methodology used for analysis in the study is Regression Analysis, between import quantities of coal and crude oil over the past 10 years was checked checked for correlation against economic indicator Fiscal deficit. The analysis has been carried out through Microsoft Excel. Once the correlation was established, and the statistic relation between the variables taken was analysed and inference was done based on the result that was obtained. The influence of crude oil import and coal import on fiscal deficit is checked for as it varies per unit. The trend for the above is also projected and how this inflicts upon the Indian Economy is discussed.

1.5 LIMITATIONS OF THE STUDY

The study is being conducted through methodically planned research. However, certain constraints present itself and hinder the researcher from covering the sections within the scope in its entirety. These limitations are beyond the control of the researcher and are limitations to the study.

Some of these limitations are

- All data sources are secondary sources based from the ministry sources' disclosure and is not verifiable or collectable on a primary basis.
- Though the study focuses on the impact of the imports of the products coal and crude oil on the Economy, only two indicators have been taken to represent the economy. However, the parameters are the most ideal ones.
- The study is limited to only ten years from 2010-11 to 2019-2020 as opposed to taking twenty years which would have been more appropriate for regression and multivariate analysis. This was not

possible due to lack of availability of data for import of coal of the years between 2000-2010.

- The researcher attempted conducting regression analysis and multivariate analysis using other economic indicators like Gross Domestic Product (GDP). However, the results were not theoretically explainable. GDP is expected to have a negative correlation with fiscal deficit and imports of crude oil and GDP, but the contrary was observed. Hence, only fiscal deficit was taken to reflect the impact on economy.

1.6 CHAPTER SCHEME

The first chapter deals with the introduction on how important coal and crude oil are in the context of India's Energy and Transportation sector and the need to meet the demand and why imports are required for the same. This is followed by an insight as to what study is and its objective and methodology, the scope within which the research has been conducted and the limitations it has.

The second chapter encompasses the understandings and findings from research and journal papers of various researchers as part of the literature review and have been beneficial to the area of study, the areas that research so far has addressed, the gap between the research done so far and what has to be achieved. Also, a description on the industry is given based on information from government publications.

The third chapter consists of the information regarding the various components such as Coal, Crude oil, GDP, Fiscal deficit etc. that forms the crux of the project and thus a descriptive over view of these have been included.

The fourth chapter contains findings of the research, the data collected, the methodology used and the results obtained followed by a detailed analysis of the same.

The fifth chapter is the final chapter and contains the suggestions and recommendations from the research, certain conclusions and a brief of how further research can be done on the matter of concern.

CHAPTER II

REVIEW OF LITERATURE

2.1 REVIEW OF LITERATURE

An Analytical View of Crude Oil Prices and Its Impact on Indian Economy
by Dr. K. Soundarapandiyar, Dr. M. Ganesh

Soundarapandiyar *et al* (2017) highlights the fact that in the Indian context, to achieve rapid economic growth and reduce impacts of inflation, crude oil is a crucial factor, thereby inflicting upon the economy. India is the 4th largest consumer of crude oil and imports over 100 million tons of crude oil annually which is actually 37% of India's total import – so we see a very huge amount of India's expenditure on crude oil and its heavy dependence on crude oil. Thus, it is evident that the price of crude oil will affect the economy like a bullwhip effect. The research is about understanding how price of crude oil varies with economic indicators like GDP and CPI for a period of 15 years i.e. 2001 to 2015.

Soundarapandiyar *et al* (2017) further sheds light into the global energy consumption at the end 2011 to be at 12274.6 million tonnes of oil equivalent. Out of this 33.06% is of crude oil followed by coal at 30.34%. Natural gas comes in at 3rd position with 23.67% followed by hydroelectricity, nuclear energy and renewable energy respectively all together less than 15%. It can be seen that crude oil and coal are of at most importance to the energy sector globally, and this trend reflects on India as well. A prominence of natural gas has been rising and will continue to due to environmental sustainability measures and all sectors aiming to curtail CO₂ emissions.

This heavy dependence on crude globally has implications and hence inflicts every country when crude oil prices vary – it gives the example of how when crude prices fell by 40% the resultant was crisis in countries like Russia which depend on oil export. For countries like India being importers of oil, when prices fall India benefits as the value of export goes down hence helping reduce the fiscal deficit – a fall in price by USD 10.00 / barrel would reduce fiscal deficit by USD 9.2 billion. Where as a rise in prices would cause price rise in all commodities there by reaching a state of inflation. However, a rise in value also troubles India, since India is the 6th largest exporter of petroleum products – so a balance is needed.

There is a vast gap between India's demand for crude oil and its own production, so imports are required. The dependence on imports keep rising as demand increases and India fails to produce its own crude. Prices rising rapidly will make imports further expensive and thus affect the economy. Statistical tools like Regression, Co-linearity and Intercorrelation have been used for the research. The outcomes of the research were Crude oil prices and CPI accounting for an 85.2% variance in GDP. It proved existence of multicollinearity between Crude oil and CPI as well as CPI and Crude oil having a negative correlation or inverse relationship. Significance tests were conducted for CPI and GDP indicating no significant difference between the two at a 5% level of significance, there by implicating that the inverse relationship and multicollinearity are applicable for GDP and crude oil prices as well. Thus, there is a relation and India must focus on developing its production or switching to alternatives to meet its demand and reduce heavy reliance on imports.

*Coal and economic development in Pakistan: A necessity of energy source
by Boqiang Lin, Muhammad Yousaf Raza*

Lin et al (2020) explores the determinants of change in consumption of coal in Pakistan during the period of 1999-2018 using models like LMDI (Logarithmic Mean Divisia Index) and I-O(Input-Output). Pakistan, like India being a developing nation with rising population and industrial activity upcoming rapidly is depended on fossil fuels for its ever-rising energy demands surviving and reducing impacts of energy crisis. The research analyses metrics like economic scale, the industrial structure, energy intensity (EI), energy mixed effects, personified coal consumption in the context of the country Pakistan. I-O and LMDI models have been applied considering the following factors viz. GDP of Pakistan, GDP of different industries, energy consumption of different industries, coal consumption of the industries, output from the coal industrial sector and coal imports for the period of 1999-2018. The study had the following conclusions –

- In the defined period industrial sectors especially involved in cement, brick and power sectors indulged in heavy coal consumption.
- The effect of economic scale had a major contribution and was found to be the only factor increasing the coal consumption and was stable; whereas energy intensity, industrial mix and energy mix have rather mixed effects.
- Since energy intensity, power distribution and energy mix have mixed effects, this indicates that the industrial structure is inefficient
- Coal utilization has increased with sectors becoming coal intensive and consumption increasing. The rate of production increases by 6.2% and rate of coal imports increases by 29.8% annually.

Crude Oil Import Elasticity of Demand in India: An Empirical Analysis 1987-2016 by Rashmi Ranjan Paital, Subhendu Dutta, Aruna Kumar Dash

Paital et al (2019) analyses the elasticity of demand of crude oil during the 30-year period lasting from 1987-88 to 2016-17 using the cointegration technique called Auto Regressive Distributed Lag (ARDL). The study utilizes macroeconomic variables like real crude oil price and real GDP, and was an attempt to determine the long-run elasticity and short-run elasticity of crude oil demand in the background of an Indian context. Paital et al describes that the long-run income elasticity coefficient was analysed and found to be statistically significant with expected sign in their empirical analysis. The researchers further came up with findings that the crude oil import demand is highly elastic to income in the long-run by which it can be inferred that a 1% increase in the Indian GDP would lead to a 2.89% increase in the demand of crude oil import. Furthermore, this study revealed that the responsiveness of international crude oil price changes in import demand are not significant. It can be stated that crude oil demand in India is highly sensitive to income changes as compared to price changes. Paital et al states that full control of the retail price of the petroleum products by the Government of India is a contributing factor to the above. Government of India completely regulated the petroleum prices for which changes in international crude oil price have not mirrored onto the retail price of the Indian scene. Also, as a growing economy, the government requires to import increased quantities of crude oil irrespective of price fluctuations of the market to satisfy and cope with the rising hinterland demand. Finally, Paital et al concludes the research paper emphasizing on the need for a structured policy framework for reducing the exploitive domestic crude consumption and suggests on exploring alternative energy source options.

Crude oil import of India from its major oil trade partner countries: An empirical evidence using panel data analysis by Narendra N Dalei, Hiranmoy Roy, Anshuman Gupta

Dalei et al (2017) study involves estimating the crude oil import of India during the period 2000-2014 considering United Arab Emirates, Nigeria, Kuwait, Saudi Arabia, Iran, Iraq, Venezuela, Malaysia, Mexico, Qatar, Brazil as India's major crude oil trading partners. Macroeconomic factors namely GDP per capita, crude oil consumption and production and FDI of respective countries have been utilized for this analysis to understand the implications. Dalei et al (2017) uses a fixed effect model of panel data analysis in terms of pooled OLS using country specific dummy and studies their interaction with the macroeconomic factors. The intercept and slope coefficient was allowed to vary across countries as the researchers estimated the crude oil import function for India. Findings from the research indicated United Arab Emirates as the most preferred nation relatively when compared to Saudi, Iraq, Iran and Malaysia in terms of import of crude oil for India - whilst controlling all other parameters except GDP per capita. UAE continued to be relatively and significantly least preferred nation for compared to Nigeria, Iran, Mexico, and Venezuela to import crude oil for India. Furthermore, the study also indicated that the GDP per capita plays a significant role in forecasting the Indian function of crude oil import with UAE especially with UAE being relatively the most preferred nation than Kuwait and Venezuela when other parameters were kept constant. The research concludes pointing out suggestions that urge macroeconomic planners, policy makers, and crude oil import companies to take judicious decisions in case of implementing policies with respect to oil import.

Economic Growth, Oil Consumption and Import Intensity: Factor Decomposition of Imported Crude Oil Model Approach by Cheng-Yih Hong and Chen-Jung Hsu

Since Taiwan's economy is export intensive, trade is the backbone of Taiwan's economic welfare – accounting to 94.41% of Taiwan's GDP. On the contrary, for its energy consumption and to meet the export demands Taiwan has to import 98% of resources of energy, mainly crude oil. Hong et al (2018) analyses the variation in the intensity of import of crude oil in the period 1981-2016. The study provides a comprehensive insight and understanding about the properties and production technologies of various industries of various sectors. The result indicate that imported goods intensity is the maximum in the crude oil sector. Variations that occur in imported crude oil intensity rises from mainly the domestic production structure and final demand structure. The results of the empirical study enumerate on how the domestic energy intensity has decreased and imported crude oil intensity has increased annually. This energy dependence can be seen to reflect upon how responsive Taiwan is to international crude oil pricing. Taiwan is ultimately trying to reduce extreme reliance on trade as a driver of growth as though it brings down the trade surplus will focus on increasing domestic demand and rather encourage investing in the domestic private sector in the country.

Electricity system scenario development of India with import independence in 2030 by Priyanka Laha, Basab Chakraborty and Poul Alberg Østergaard

Laha et al (2019) comprehensively conducts a scenario study to investigate India's transition from fossil fuel to renewable energy-based power generation in the context of electricity systems in India. India is heavily reliant on coal for power generation, approximately 76%. This research was unique unlike scenario presentations and incorporated dynamic simulation and assessment of optimal renewable energy contributions to be compared

with the optimal electricity system. The results from the research indicated that an optimal scenario could supply electricity hourly by – increasing production capacity, bettering and improving capacity factor of photovoltaic cells and wind power thereby increasing wind power production and solar photo voltaic, river hydropower, biomass and nuclear power. The costs identified in the optimal scenario are significantly lesser. Simulations indicated that biomass and nuclear inclusion in optimal proportions will bring down and eliminate import dependency on coal.

Estimating coal production peak and trends of coal imports in China by Bo-qiang Lin and Jiang-hua Liu

China has the 3rd largest of coal reserves in the world and it one amongst the largest consumers and producers but hasn't reached its peak of production. Lin et al (2010) analyses how that the peak may be achieved in the period 2020-2030 and how the coal imports of China can be forecasted. Lin et al also study the impact of China's net coal import on the Asian coal market and internationally and to what extend this would inflict on China's energy security and economic development and ultimately the Chinese economy. The methodologies used for the study include logistic growth model, Gaussian model and STELLA model. The import trends indicate that the volume of imports will increase and dependence on coal imports will be high and 50% of the worlds coal would be traded with China significantly affecting coal prices especially in the Asian market. It would be rather unfortunate if China moves on and expands with an energy structure system heavily dominated by the coal industry as its economic growth may not be sustainable especially when looked at in light of the supply of coal and the environmental capacity. Policy suggestions have to come up with regards to renewable energy sources.

Import demand of crude oil and economic growth: Evidence from India by Sajal Ghosh

Ghosh (2009) through study establishes a long-term equilibrium relation or equation between the crude oil import quantity, price of crude oil imports, income, for the period 1970-71 to 2005-06 using ARDL (autoregressive distributed lag) which is a testing approach of cointegration. From the empirical results it is obtained that the income elasticity of crude oil import demand is greater than 1 indicating the price sensitivity of coal imports in the long run. Ghosh further states that in the long run, reduction of crude oil import will not affect future economic growth of India and puts forward suggestions in the direction that India must take into consideration energy efficiency, demand side management measures in the power and transport sector and focus on expanding and bettering its indigenous resource base to increase domestic fuels and reduce imports by also controlling prices.

Quantifying China's oil import risks and the impact on the national economy by Mei Sun, Cuixia Gao and Bo Shen

Sun et al (2014) explores the influence of China's oil import risks (OIR) on its national economy and industrial sector through a systematic and quantitative methodology including multiple linear approach and input-output model. The risks from oil transportation routes (piracy, geographical politics influencing shipping routes) and exporting country risks (arising from political changes or internal conflict etc.) are integrated to quantify the OIR. It is the I-O analysis used to identify impact of OIR on GDP or rather the economy. The study indicates that an OIR increase of 10% will cause an increase of 2.41% on China's oil import cost, and a decline of China's GDP by 0.37%. In its domestic sectors the value chains are affected with maximum impact being on direct oil-based industries involved in processing and extraction and relatively lesser on transportation, warehousing and chemical industries. It emphasises on how issues with purchase,

transportation and distribution of oil imports will increase OIR and effect on the Chinese economy. Thus, this requires strengthening and mitigating risks in the supply chain and reduce dependence on oil imports, enhance production and invest in alternative fuel sources.

Relationship between Crude Oil Prices and Stock Market: Evidence from India by Ankit Sharma, Sasmita Giri, Harsh Vardhan, Sujeet Surange, Rohan Shetty and Vishwaroop Shetty

Sharma et al (2018) estimates the linear dependencies and interdependencies between stock mark indexes in India and international crude oil prices using VAR (vector autoregressive) framework during the period of 2010-2017. Crude oil futures prices, NIFTY index and BSE energy index have been used for the analysis. In the unit root analysis, it is concluded that crude oil futures prices, nifty and BSE EI time series are integrated to the order of 1. The cointegration test revealed long term relationships between these three time series is absent and can not be used to determine the time series of each other. Further proceeding with the VAR model, it is observed the EI was explained by all the three variables which were lagged. Oil prices are affected when stock indices have a shock as an impulse. The effect of this shock is more on EI than nifty and increase with time.

Traditional energy resources in India (coal, crude oil, natural gas): A review by Lari Shanlang Tiewsoh, Martin Sivek and Jakub Jirásek

Tiewsoh et al (2017) comments that India is a country with a rising population and growing economy – from a GDP growth of 5% in 2013 to World Bank projections of increase of 5.5% in 2014 to 6.8% in 2016 and so on. The need of energy to sustain the growth rate is mentioned where India relies primarily on coal followed by oil and then natural gas. Consumption and demand increased by slightly over 100% between 2000

and 2013 on the contrary share of reserves only changed by 1%. To meet demands there is heavy requirement of coal and crude oil imports since production does not meet demands. However, India is self sufficient for its refining needs and is actually an exporter of POL products. Gap between demand and production increases – high amounts of coking coal demand due to steel manufacturing relatively lesser demand of thermal coal for power plants but due to inferior quality imports required. To minimize the effect India is in the search of alternative fuel sources – nuclear energy, coalbed methane and other renewable resources. The current trends and issues are seen both in India and China and a competition between these two countries is bound to reflect in multiple directions but mainly on the prices of energy minerals on a global level.

What deteriorates India's current account balance: crude oil imports or gold imports? Manoranjan Sahoo, Hrushikesh Mallick and Mantu Kumar Mahalik

The research uses linear cointegration techniques for analysing the impact of crude oil and gold imports on the Current Account Balance (CAB) of India during the period 1980-2017. The results show that the crude oil imports contribute positively to the Indian CAB (in the short run) and can be explained through the following reasons –

- India has been one of the largest crude oil importers globally and also re-exports a great proportion of its imported oil after refining and has been increasing sharply – so a considerable portion of its imports are not just for India's consumption but value added and exported
- It is mentioned that crude oil used enhances the Total Productivity Factor (TPF) and thus enhances output growth, which in turn benefits and increases Indian exports thereby improving India's CAB

However, the fact that India's crude oil import dependence adversely impacts CAB over a long period when the price of crude oil globally is

considered. Oil price shocks severely hit the trade balance of the economy of India.

When good intentions turn bad: The unintended consequences of the 2016 Tanzanian coal import ban by Thabit Jacob

Jacob (2019) discusses about the background of the implementation of a coal ban in Tanzania, the effect it proposed to bring and how the policy backfired. TANCOAL was the single coal producer in Tanzania which was a joint venture between the state-owner National Development Corporation and Intra Energy Corporation of Australia. The ban was initiated aiming at preventing imports of cheap coal, safeguarding the economy based on the coal sector and unfair competition. Local consumers were to procure coal domestically thereby initializing the protectionist industrial policy. There was a lot of backlashes from the steel and cement industries being the primary users of coal – with regard to inferior quality of domestic production. Power generation was also influenced and took a hit. Unable to supply coal – steel and cement industries suffered. Two years post the ban industries are reviving – switching over to gas to meet power requirements. Countries have imposed ban and lifted bans on coal prior to this and have had their share of effects. Such policy making must be done in balance with considering and consultation with stakeholders.

2.2 LITERATURE SURVEY

The research prospects under this field of study are plenty. From reviews of the journal papers, it is evident that there is a lot of research that has been carried out for years on how coal and crude oil being fossil fuels have been consumed worldwide for power generation and refined and used for fuel purposes, also their importance in the manufacturing sector as raw material – their production, the need for import due to limited reserves etc. It is witnessed that in growing economies like that of India's these play a

vital role and price fluctuation of the international market inflict upon its availability, demand and supply, and the GDP of the country. As the world progresses and mankind realizes the environmental impact researches are being conducted on viability of using renewable resources and the need to switch to such resources reducing not only the environmental impact but also excessive dependency on imports of these goods. In almost all researches there is a conclusive suggestion highlighting the role of the government and need of suitable framework to achieve the import and production balance, as well as regarding using alternative energy resources.

2.3 LITERATURE GAP

The researches so far have been made on the basis of various models. However, such researches are more to the statistical analysis aspect and do not consider more than a set limit of factors and thus do not provide a wholesome picture. Also, when most researches are conducted in this aspect it generally regarding the total coal or crude oil or with respect to the production aspect. The import of coal and crude oil and its impact has not completely been analysed to its entirety. It has been more or less generically stated that import dependency needs to be reduced, due to the effect on trade balance. There needs to be further pondering on the concept. This study helps to take this aspect a little further by focussing on imports exclusively and studying the impact on not only GDP but also the fiscal deficit.

CHAPTER III

PROFILE OF THE INDUSTRY

3.1 COAL

3.1.1 Introduction

Coal is a brownish-black or black rock formed in rock stratas also known as coal seams and is a type of sedimentary rock. It is primarily a compound of carbon. Other components include quantities of hydrogen, sulphur, oxygen and nitrogen. Its formation takes millions of years, deeply buried, when dead and decayed plant matter convert into peat and then into coal due to extreme heat and pressure.

Coal is categorised into mainly 5 categories based on the depth of burial and temperature conditions that ultimately forms coal with different carbon contents. This can be described in a nutshell as seen in Figure 2.1.

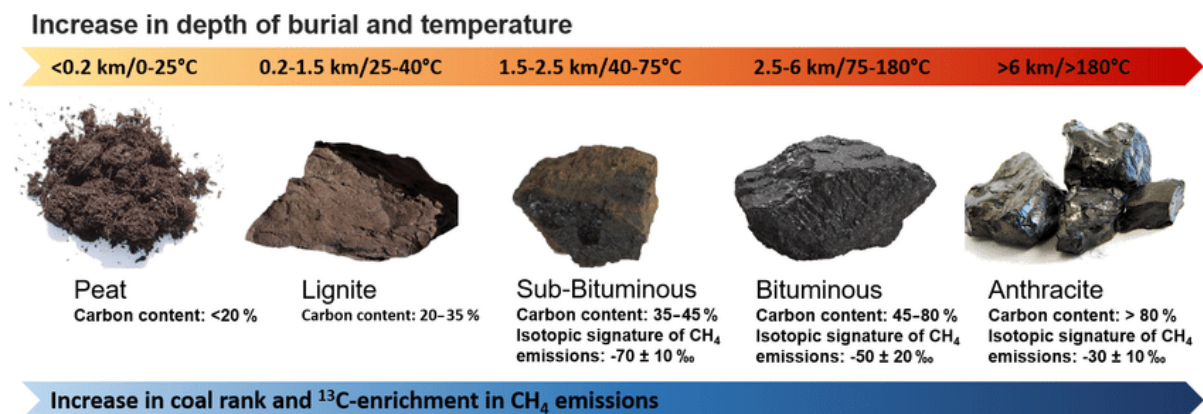


Figure 3.1 – Coal Mining in India

As there are geological processes that apply a lot of pressure to dead and decaying biotic substances or materials over time be it flora or fauna, under

certain specific and suitable conditions, it undergoes its metamorphosis like metamorphic rocks do and thus, its metamorphic grade or rank substantially increases in succession to develop into the following types of coal –

- Peat is form of a precursor of coal
- Lignite which is also known as or brown coal is one of the lowest ranks of coal. It is the most dangerous and harmful to health when exposed causing variety of diseases mostly respiratory. It is used almost exclusively and extensively for fuelling purposes in electric power generation sectors.
 - Jet is a very compact form of lignite or brown coal which is seldom sometimes polished state. It is often seen to be used as an ornamental stone since the Upper Palaeolithic era in jewellery and ornamental decoration pieces due to its shiny lustre.
- Sub-bituminous coal is the type of coal in which its properties almost range from between those that are observed in lignite and those of which are observed in bituminous coal. Sub-bituminous coal is used primarily and widely for generation steam-electric power generation like in the steam engines of ancient times.
- Bituminous coal is a highly dense form sedimentary rock of coal which is generally pitch black, but it is seldom seen to be of dark brown shades and often contain well-defined, distinct bands of vividly bright and dusky-dull materials with some lustre. It is used for fuelling in the generation of steam-electric power and is also used extensively to make coke. In the United Kingdom, it is popularly known as steam coal due to its historic use in steam engines and also in steam locomotives and ships for steam raising.

- Anthracite possesses the highest quantity of coal which is above 80% and thus is the highest rank of coal. It is way more harder than the other types of coal. It has a glossy black appearance and this type of coal used primarily for residential and commercial space heating in case of winters and used in fireplaces.
- Graphite is a unique form of carbon or coal. It is slippery due to its multi-layered hexagonal lattice structures. It is highly conductible, an excellent conductor of electricity and is extremely difficult to ignite and thereby not commonly used as fuel as it is not ideal. It is most extensively used in lead of pencils or powdered for lubrication due to its slippery nature.

3.1.2 Ministry of Coal

The Ministry of Coal has its headquarters in New Delhi and is handled currently by the Cabinet Minister Shri. Pralhad Joshi.

The organization structure of the Ministry starts with the Cabinet Minister of Coal, Mines and Parliamentary Affairs followed by the Secretariat of Ministry of Coal, which is headed by a Secretary who is assisted by 1 Additional Secretary, 4 Joint Secretaries (including the Financial Advisor), 1 Project Advisor, 1 Economic Advisor, 8 Director/Deputy Secretaries, 2 Technical Directors, 11 Under Secretaries, 21 Section Officers, 1 Joint Director (Official Language), 1 Assistant Director (Official Language), 1 Controller of Accounts, 1 Deputy Controller of Accounts, 2 Senior Accounts Officers, 4 Assistant Accounts Officers and their supporting staff.

This Government of India ministry is in charge of exploration of coal and lignite reserves of India; the production, supply and distribution of coal in the country and its trade; also, it is involved in price regulation. This is done through government owned corporations such as Coal India Limited (CIL), its subsidiaries and Neyveli Lignite Corporation India Ltd. Ministry of Coal also has administrative control over Singareni Collieries Company, Telengana.

The functions and responsibilities of Ministry of Coal as per the GoI (Allocation of Business) Rules 1961 are –

- Exploring and developing coking and non-coking coal as well as the lignite deposits of India
- Affairs of production, distribution, supply and price related to coal in India
- Administration activities of coal bearing areas – acquiring and developing
- Developing and operating coal washeries except the ones that Department of Steel takes charge for
- Producing synthetic oil from coal and its low-temperature carbonisation activities
- Carrying out administrative functions of the Coal Mines as per Conservation and Development Act of 1974

- To oversee Coal Mines Provident Fund Organisation and Coal Mines Welfare organisation under Miscellaneous Provision Act 1948 and Coal Mines Labour Welfare Fund Act, 1947
- Implementing and following rules under the Mines act 1952, particularly with regards to levying and collecting excise duty on coal and coke produced and dispatched from the mines.

3.1.3 Coal Reserves in India



Figure 3.2 – Coal Mining in India

Coal is the one of the major and plentiful fossil fuel resources in India. It accounts for over 55% of the country's energy requirements. From the time of ancient industrialisation, indigenous coal made up the industrial heritage of India. The country was heavily dependent on coal. Also because there was access to coal and it was readily available this was greatly promoted.

India as a developing nation is heavily into industrialisation and other economic and commercial activities, especially from the advent of liberalisation, privatisation and commercialisation. Commercial primary

energy consumption in India has tremendously grown by over an estimate of 700% in the last four decades ranging from the 1980s to the 2020s. The per capita of commercial primary energy consumption at present in India is about 350 kg of oil equivalents/year. This is way less compared to developed countries when rankings of current per capita commercial primary consumption is analysed. However, by the driven demand of the rising population which is expected to overgrow and overtake China in the upcoming decade, the continuously expanding economy and a quest for improved quality of life for its citizens, energy use of India is only expected to rise further multifold. When we take into consideration the lean reserves and capability of petroleum & natural gas, restriction on hydel project for economic conservation, geo-political perception of nuclear power, coal will continue to dominate India's energy scenario, unfortunately.

Indian coal reserves offers a unique semi-eco-friendly fuel source to the domestic energy market for the next upcoming century and beyond these times if used judiciously. Deposits of hard coal are spread across 27 major coalfields located diversely. These are mainly confined to the Eastern region and some of the Southern region and Central parts of the country. The lignite reserves of the country are mostly found to be in Tamil Nadu, occupying 90% of available 36 billion tonnes.

Exploration activities carried out by the Geological Survey of India, Central Mine Planning and Design Institute, Singareni Collieries Company and Mineral Exploration Corporation Limited etc. have been up to the maximum depth of 1200m. A cumulative total of 319.02 billion tonnes of Geological Resources of Coal have so far been estimated in the country as on 1st of April in 2018. Details of state-wise distribution of geological resources of coal are tabulated below–

Table 3.1 – State Wise Coal Reserves

State	Proved	Indicated	Inferred	Total
Total	148787	139164	31069	319020
JHARKHAND	45563	31439	6150	83152
ODISHA	37391	34165	7739	79295
CHHATTISGARH	20428	34576	2202	57206
WEST BENGAL	14156	12869	4643	31667
MADHYA PRADESH	11958	12154	3875	27987
TELANGANA	10475	8576	2651	21702
MAHARASHTRA	7178	3074	2048	12299
ANDHRA PRADESH	0	1149	432	1581
BIHAR	161	813	392	1367
UTTAR PRADESH	884	178	0	1062
MEGHALAYA	89	17	471	576
ASSAM	465	57	3	525
NAGALAND	9	0	402	410
SIKKIM	0	58	43	101
ARUNACHAL PRADESH	31	40	19	90

(in Million Tonnes) Source: Geological Survey of India

The table indicates that the highest quantity of reserves are located in the states of Jharkhand and Odisha followed by Chhattisgarh, West Bengal, Madhya Pradesh and Telangana. This indicates the concentration of reserves to be most at Eastern and Central India.

It must be noted that the classification of proved or measured, indicated and inferred are as per Indian Standards Procedure also known as ISP. Proved or measured coals are those resources of coal of an area within 200m radius from a borehole or observation point. In case of indicated coal reserves the lie in the area between the radii of 200m and 1km from the borehole or observation point. Further more there is one more classification known as the inferred reserves of coal. These are coal reserves falling in the area between radii of 1 km and 2 km from the observation point of the borehole.

These resources of coal are categorised based on formations as well. The Coal mine reserves of India are discovered to be in the older Gondwana Formations of peninsular India and younger Tertiary formations of North-Eastern region. The resources are further classified into 'Indicated' or 'Inferred' category depending on the results of whether Regional or Promotional Exploration, where in the boreholes are placed or spaced out about 1-2 kilometres from each other. Subsequent Detailed Exploration in certain selected blocks, where boreholes are less than 400 meters apart, upgrades the resources into more reliable Proved or Measured categories. The formation-wise and category-wise Coal resources of India as on 1st of April in 2018 are described in the following table –

Table 3.2 – Formation Wise Coal Reserves

Formation	Proved/Measured	Indicated	Inferred	Total
Grand Total	148787	139164	31069	319020
Gondwana Coals	148194	139065	30174	317433
Tertiary Coals	594	99	895	1588

The table indicates that India majorly has Gondwana coals. Tertiary coals are significantly lesser in quantity.

The coal reserves are also classified on the basis of the type as Coking coal, non-coking coal and tertiary coal. The coking coal is further divided into prime, medium and semi coking coals. The type of coal is indicated category-wise as per the coal resources of India as on 1st April, 2018 and were found to be as in the table given below –

Table 3.3 – Coal Reserves by Type

Type of Coal	Proved/Measured	Indicated	Inferred	Total
Grand Total	148787	139164	31069	319020
(A) Coking				
-Prime Coking	4649	664	0	5313
-Medium Coking	13914	11709	1879	27502
-Semi-Coking	519	995	193	1708
Sub-Total Coking	19082	13368	2073	34522
(B) Non-Coking	129112	125697	28102	282910
(C) Tertiary Coal	594	99	895	1588

Coking coal is also known as metallurgical coal and is high on carbon content, with very less moisture, less sulphur (which is ideal for iron and steel industry) and less ash content. Generally bituminous coals are used and heated at high temperatures in the absence of air to pyrolyze and form coke. Non-coking coals are also known as thermal coal or steaming coal and is very high on sulphur content. These coals are not suited for iron and steel manufacturing or producing coke; however, these are ideal for power generation. Tertiary coal mainly refers to Lignite and Peat. These coals take millions of years to form and have low carbon content, high moisture content as well as sulphur content.

As a result of Regional, Promotional and Detailed Exploration by GSI, CMPDI, SCCL, MECL, State Governments. etc., the coal reserves were estimated to be 319.02 billion tones in India. The increase or upgradation of coal resources in India during last 5 years is furnished in table below -

Table 3.4 – Coal Reserves from 2013 to 2018

Inventory as on	Proved/Measured	Indicated	Inferred	Total
1.4.2018	148787	139164	31069	319020
1.4.2017	143058	139311	32780	315149
1.4.2016	138087	139151	31564	308802
1.4.2015	131614	143241	31740	306596
1.4.2014	125909	142506	33149	301564
1.4.2013	123182	142632	33101	298914

3.1.4 Coal Usage

Coal has been used over the years and gained popularity vastly during the Industrial Revolution and invention of the steam engine. Coal had been used primary for fuel and currently is the world’s primary energy resource for energy and electricity. It has been used widely for power generation in thermal power plants. Coking coal has also been extensively utilized in iron and steel making. Synthetic fuel is produced through gasification and coal liquefaction. In addition to all these, coal has a role in alumina refineries, paper manufacturing, chemical and pharmaceutical industries.

3.1.5 Coal Trade

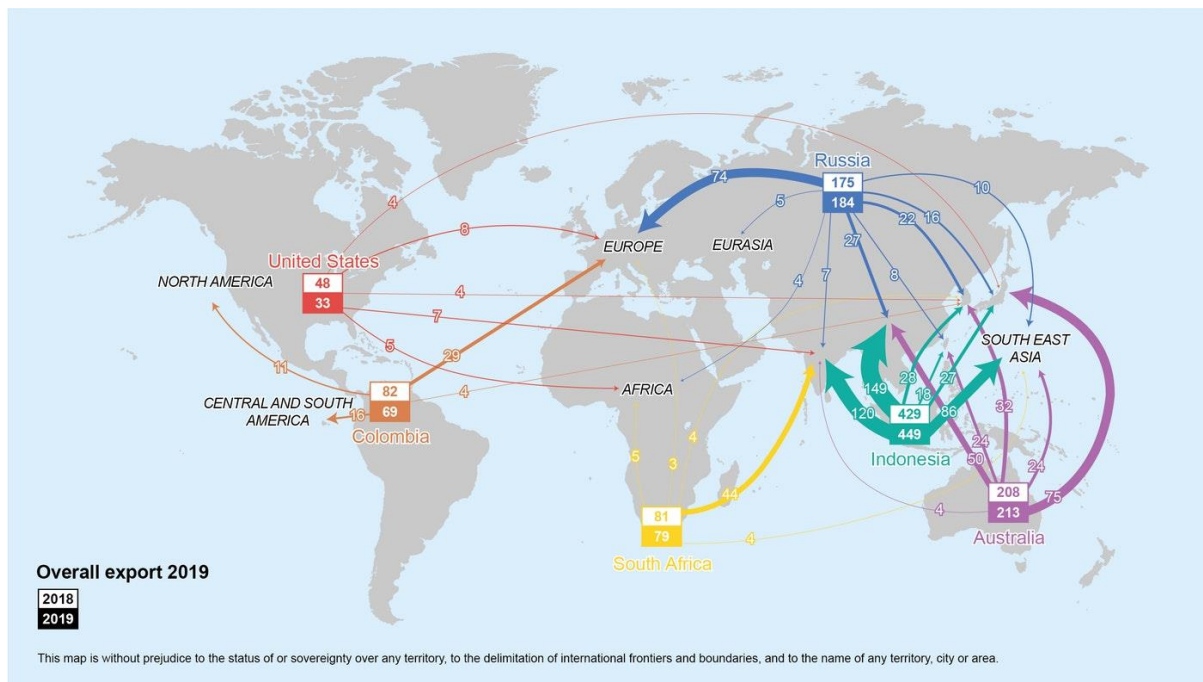
Coal trade is a widely spread, capital intensive global industry, with coal being produced from reserves in more than fifty countries and primarily consumed in more than seventy countries.

The dynamics of the global coal trade can be best portrayed by the following statistics. The coal market has swiftly risen from 357 MTs in 1999 to over 1,2 BTs which was the quantity of coal traded in 2015. About 92% of this volume traded was seaborne trade while the remaining 8% was transported overland and was trade cross the borders through road and rail.

Various reasons can be stated to explain this rapid development in the global coal trade sector. Some of these are as described as follows –

- high growth dynamics of developing countries, especially China and India
- decreasing coal production in Europe
- quality of coal
- consumers' requirements for particular parameters

Due to the high transportation and logistics costs incurred in hefty amounts, the seaborne coal trade market is traditionally divided into two sub-markets segments viz. the Atlantic market, with the most biggest importing countries which are Germany, Spain and the UK; and the Pacific market, with the most significant importing countries which are Australia, China, Indonesia and Japan.



Source – <https://www.iea.org/reports/coal-2020/trade>

Figure 3.3 – Main trade flows in the thermal coal market, 2019 (MTs)

As of 2019 the major exporters of coal are –

- Australia: US\$44.4 billion (37.5% of total coal exports)
- Indonesia: \$21.5 billion (18.2% of total coal exports)
- Russia: \$16 billion (13.5% of total coal exports)
- United States: \$9.8 billion (8.3% of total coal exports)
- Colombia: \$5.2 billion (4.4% of total coal exports)
- Canada: \$5.2 billion (4.4% of total coal exports)
- South Africa: \$4.8 billion (4.1% of total coal exports)
- Netherlands: \$3.2 billion (2.7% of total coal exports)
- Mongolia: \$3.1 billion (2.6% of total coal exports)
- Mozambique: \$1 billion (0.9% of total coal exports)
- China: \$932.8 million (0.8% of total coal exports)
- Poland: \$622.8 million (0.5% of total coal exports)
- Philippines: \$460.6 million (0.4% of total coal exports)
- Kazakhstan: \$449.7 million (0.4% of total coal exports)
- Belgium: \$217.3 million (0.2% of total coal exports)

As of 2019 the major importers of coal are –

- Japan: US\$23.3 billion (17.6% of total imported coal)
- India: \$23 billion (17.5% of total imported coal)
- China: \$18.9 billion (14.3% of total imported coal)
- South Korea: \$14.1 billion (10.7% of total imported coal)
- Taiwan: \$7 billion (5.3% of total imported coal)
- Germany: \$4.5 billion (3.4% of total imported coal)
- Netherlands: \$4.4 billion (3.4% of total imported coal)
- Turkey: \$3.6 billion (2.7% of total imported coal)
- Malaysia: \$2.9 billion (2.2% of total imported coal)
- Brazil: \$2.9 billion (2.2% of total imported coal)
- Vietnam: \$2.2 billion (1.7% of total imported coal)
- Philippines: \$1.9 billion (1.4% of total imported coal)

- Poland: \$1.7 billion (1.3% of total imported coal)
- France: \$1.6 billion (1.2% of total imported coal)
- Ukraine: \$1.5 billion (1.2% of total imported coal)

Global trade of coal had reached its highest volume ever in 2019 with its peak at 1445 MT. This was a 0.8% increase from the previous year, 2018. In 2019, coal trade was said to account for over 19% of global coal consumption. Trade in non-coking or thermal coal increased 1.1% while metallurgical or coking coal trade volumes were stable and more or less constant. Non-coking coal accounted for 76% of global coal trade and coking coal for the remaining 24%.

According to the IEA 2020 trade volumes of coal would recede to around 10% which would be approximately 150 MT bringing the largest dip ever in seaborne coal trade. Volumes of thermal coal were to decline by 10% and those for coking coal by 12%. The largest exporters of coal have to bear the brunt of the extreme decline in exported volumes this was spread across affecting Indonesian exports the maximum and were said to drop by 51 MTs (-11%) and the exports from Australia by 30 MTs (-8%). On the import side, the biggest absolute decrease in imports was witnessed in India (-41 MTs).

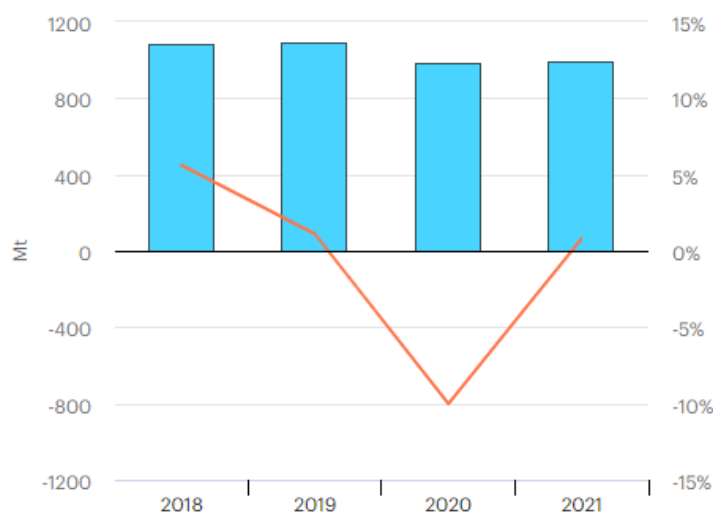
In 2021 as the world recovers and recoups the aftermath of COVID-19 shocks in the trade aspect, coal demand is set to recover, traded volumes would also rebound. Exports are expected to increase by 31 MTs (2.4%) to 1323 MTs in 2021 when compared to what was witnessed in 2020. This indicates that export volumes will remain way below the volumes seen in the pre-Covid era. However, this recovery phase will be supported by more imports demand from India (+12 MTs) and other Southeast Asian regions (+10 MTs). This will ultimately benefit Australia (where a rise by 20 MT is

expected) and Indonesia (where a rise of 6 MT is expected) in particular to rise from the extreme losses borne by the exporters due to COVID-19.

To quote –

Rome-based Assocarboni President Andrea Clavarino told S&P Global Platts in an emailed statement quoted that *"Seaborne trade will start to grow again: a 5% increase in volumes traded is expected by the end of 2021, with a final total figure of 1.21 billion mt,"*

He further went on to say that *"In particular, thermal coal should amount to 947 million tons (+ 4% compared to 910 million in 2020) and metallurgical coal to 263 million tons (+6% compared to 247 million in 2020)."*



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● Thermal coal ● Annual growth

Source – <https://www.iea.org/reports/coal-2020/trade>

Figure 3.4 – Trade development for thermal coal 2018-2021



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● Metallurgical coal ● Annual growth

Source – <https://www.iea.org/reports/coal-2020/trade>

Figure 3.5 – Trade development for metallurgical coal 2018-2021

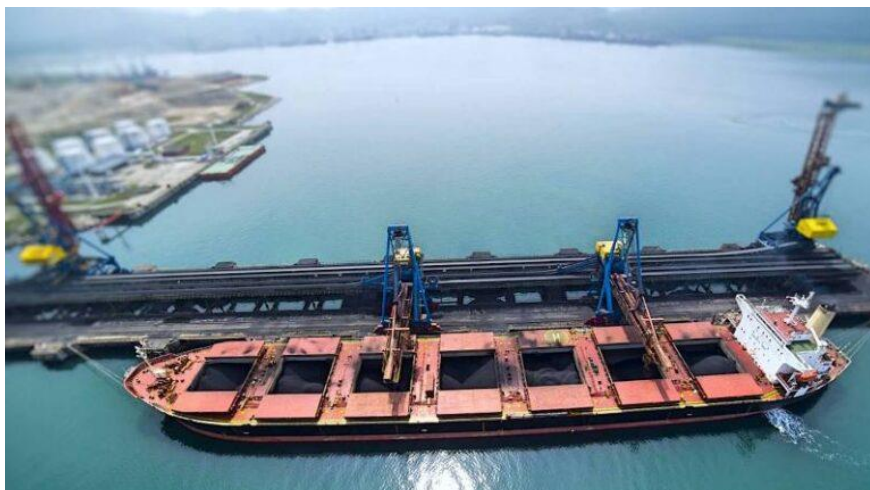
Viewing the trends of coal trade from the historical view, the coal market exhibits that coal prices have remained more or less stable and constant and way more affordable when compared to than the prices of crude oil or natural gas. After the price hikes in 2008 due to the global economic crisis period, the coal prices have recovered really well and the market did return closer to its previous equilibrium. Coal price projections have always indicated that coal will remain the most affordable resource in the following decades and hence be widely preferred, especially by developing nations like China and India. However, the market volatility of its prices, susceptible to fluctuations especially during economic crises will be high.

3.1.6 Transportation

There are a number of coal suppliers worldwide those of which are active on the coal market and they facilitate and ease the transportation efforts for coal by rail or by sea aiming to ensure efficient, smooth and competitive functioning of the global coal market.

Coal can be transported easily due to the variety availability of multiple modes of transportation, which makes it economical, simple and with special attention to safety. The mode of transport chosen mostly depends on the distance to be covered, the water or land mass in between, available routes and modes and economical concerns. However, it is seen that over 90% of all transported coal is handled with large bulk carriers which are found to be ideal. Coal is generally carried in the following bulk carriers –

- Handysize – 40 to 45 kt
- Panamax – 60 to 80 kt
- Capesize – over 80 kt



Source – <https://www.iea.org/reports/coal-2020/trade>

Figure 3.6 – Bulk Carrier loading Coal

The other 10% of coal is transported overland through road or rail.

Transportation costs from the coal mine to the consuming power plant can often account for 80% to 90% of the final price of coal and thus optimisation is a key challenge.

There are two factors that have effected the location of terminals: the location of exportable natural resources (coal and iron ore), and by availability of hinterlands transportation. Coking coals are primarily imported through Vizag, Paradip, Kolkata, Krishnapatnam, New Mangalore and Mormugao. While there is a vast railroad network within India, it is insufficient to meet the needs of transporting coal from the mines to the plants and utilities that need it.

3.2 CRUDE OIL

3.2.1 Introduction

Crude oil is a naturally occurring petroleum product which constitutes of hydrocarbon deposits and other organic material. Being a type of fossil fuel, crude oil is refined through various processes at refineries to produce products also known as POL products which include gasoline, diesel and other forms of petrochemicals. These components of petroleum are separated using a technique called fractional distillation that involves separation of a liquid mixture (crude oil in this context) into various fractions which differ in boiling point by method of distillation, which requires using a fractionating column apparatus. Crude oil consists of naturally occurring hydrocarbons of various molecular weights and thus may contain miscellaneous organically occurring compounds. Crude oil or petroleum is formed when large quantities of dead organisms mostly like zooplankton and algae are buried in layers of the strata underneath sedimentary rocks and subjected to both intense heat and pressure. The process is similar to coal formation. However, coal formation is related to flora and petroleum formation is related to fauna. Like most fossil fuels

crude oil is also non-renewable, exhaustible resource, which means that it can't be replaced naturally at the rate it is consumed and thus is limited in quantity.

Crude oil recovery is mostly done by oil drilling. This extracted crude oil is refined and separated, most easily by distillation, into numerous products for direct use or to be used in manufacturing products. Some of the products from crude oil are petrol, diesel, kerosene, asphalt and chemical reagents. These are in turn used for plastics, pesticides and pharmaceuticals production. Petroleum is used in the manufacturing industry widely to produce a range of varied materials. Petrol is estimated be consumed at rate of about 100 million barrels per day worldwide. Petroleum production was crucial and was a strong indicator and factor for economic development in the 20th century. Countries with strong reserves and production gained the status of 'oil states' achieving significant economic growth and development due to their upper hand in international circles over the black gold liquid and control of its flow and international market prices. The oil business can be extremely profitable and as it is significant for all countries whether developing or developed.

Petroleum exploitation has significant impact on the environment and has severe social consequences and repercussions. Extraction, refining and combustion of petroleum fuels all end up in significantly large quantities of greenhouse gases emissions thus becoming one of the major contributors to climate change and different forms of pollution. Some other negatively impacting environmental effects also are from the exploration and exploitation of petroleum reserves and its transportation. Unfavourable situations may occur like oil spills, and air and water pollution at the sites of its utilization, procurement and processing. All these environmental effects have proven to reflect directly as health hazards for humans. Oil has

also been a source of conflict leading to both state-led-wars and other kinds of political conflicts like between Kuwait and Iraq etc.

Production of petroleum is expected to reach its peak oil before the year 2040. This peaking is expected as responsible global economies will focus on reducing their dependencies on petroleum as part of climate change mitigation initiative and a transition towards renewable energy resources and electrification in addition to protecting national interests and economy which are susceptible to fluctuations in the market price. This is further expected to have significantly large economic impacts that the stakeholders involved in oil trade are at disagreement, and argue the need to anticipate this transition and appropriately address the stranded oil resource assets of the crude oil industry.

3.2.2 Ministry for Crude Oil

The Ministry of Petroleum & Natural Gas is responsible for the exploration and production activities of Crude Oil & Natural Gas; its refining, distribution and marketing, import, export and conservation of by-products of by refining and distillation of crude oil. Crude oil is one of the most important imports for our economy as India has limited resources to meet its ever-growing population's demand; as well as to maintain its pace of economic development. Several initiatives have been put into place and have been undertaken by the Ministry of Petroleum & Natural Gas for increasing India's production capacities and exploration & exploitation of all the available domestic petroleum resources to primarily the import dependence and address the priorities of access to energy, efficiency of energy, the sustainability of energy production processes and energy security. The initiatives undertaken for the above-mentioned purposes are listed below as per stated in the website of the Ministry of Petroleum & Natural Gas.

- Hydrocarbon Exploration Licensing Policy.
- National Data Repository.
- Discovered Small Field Policy.
- 2D Seismic Survey.
- Natural Gas Grid and City Gas Distribution.
- Refineries and Auto Fuel Vision and Policy.
- Implementation of BS-IV & BS-VI.
- Pradhan Mantri Ujjwala Yojana and PAHAL.
- Gram Swaraj Abhiyan
- Extended Gram Swaraj Abhiyaan.
- Direct Benefit Transfer Kerosene.
- National Policy on Biofuels 2018.
- Compressed Bio Gas Plants.
- Neighbourhood First Policy.

The Ministry of Petroleum & Natural Gas functions and is dedicated to carry out the following work.

- Exploration for, and exploitation of petroleum resources, including natural gas and Coal Bed Methane, gas hydrates and shale gas.
- Production, supply, distribution, marketing and pricing of petroleum, including natural gas, Coal Bed Methane and petroleum products.
- Oil refineries, including Lube Plants.
- Additives for petroleum and petroleum products.
- Blending and blending prescriptions for bio-fuels including laying down the standards for such blending.
- Marketing, distribution and retailing of bio-fuels and its blended products.

- Overall coordination concerning bio-fuels, National Policy on Bio-fuels, policy/scheme for supporting manufacturing of bio-fuels, setting up of a National Bio-fuel Development Board and strengthening the existing institutional mechanism. Further to the above, R&D and demonstration on transport, stationary and other applications of biofuels are also included.
- Lube Blending and greases.
- Conservation of Petroleum products.
- Planning, development, control and assistance to all industries dealt with by the Ministry.
- Strengthening energy security by acquiring oil and gas equity abroad and participation in transnational oil and gas pipeline projects.
- Planning, development and regulation of oilfield services.
- Creation and administration of strategic petroleum reserve through Indian Strategic Petroleum Reserves Limited (ISPRL).
- Petroleum Planning and Analysis Cell (PPAC).
- All attached or subordinate offices or other organization concerned with any of the subjects specified in the list, including Directorate General of Hydrocarbons (DGH), Centre for High Technology (CHT), Oil Industry Development Board (OIDB), Petroleum Conservation Research Association (PCRA), etc.

- Administration of Engineers India Limited (EIL), including their subsidiaries and joint ventures.
- Public sector project falling under the subject included in this list except such projects which are specifically allotted to any other Ministry / Department.

3.2.3 Reserves and production

The crude oil reserves of India on 31 March 2019 is estimated to be around 618.95 million tonnes (MT). This is more than 4.1% compared to the previous year. The Western Offshore (Mumbai High, Krishna-Godavari Basin) (40%), and Assam (27%) contribute to the major share of crude oil reserves. The natural gas reserves was estimated to be around 1,339.57 billion cubic meters (BCM) in India as of 31 March 2018. This is more than 3.87% from the previous year. The Eastern Offshore (38.13%) and the Western Offshore (23.33%) contribute to the major reserves of natural gas.

Estimates of crude petroleum and natural gas reserves in India by state/region as on 31 March 2017 is depicted in the table below.

Table 3.5 – State Wise Crude Oil Reserves

Region	Crude oil reserves (in MMT)	Share of oil (%)	Natural gas reserves (in BCM)	Share of gas (%)
Arunachal Pradesh	1.52	0.25	0.93	0.07
Andhra Pradesh	8.15	1.35	48.31	3.75
Assam	159.96	26.48	158.57	12.29
Coal Bed Methane	0	0	106.58	8.26

Eastern Offshore	40.67	6.73	507.76	39.37
Gujarat	118.61	19.63	62.28	4.83
Nagaland	2.38	0.39	0.09	0.01
Rajasthan	24.55	4.06	34.86	2.70
Tamil Nadu	9.00	1.49	31.98	2.48
Tripura	0.07	0.01	36.10	2.80
Western Offshore	239.20	39.60	302.35	23.44
Total	604.10	100	1,289.81	100

3.2.4 Usage

Crude oil possesses a heterogeneous chemical structure and its composition mainly consists of chains of hydrocarbons of differently varying lengths. These long hydrocarbon chains are separated through processes like distillation and other chemical reactions are to be undergone to produce crude oil-based products at refineries to be used for multiple purposes. It is because of this heterogeneous chemical structure that this is possible.

Crude oil and its products are refined mainly to produce products that can be used as fuels. These fuels are categorized mainly by their boiling range. Some these fuels are –

- Liquefied Petroleum Gas (LPG) - LPG is used as fuel in heating appliances, cooking apparatus and vehicles. It is frequently used as an aerosol propellant and as a refrigerant thereby helping replacing chlorofluorocarbons as a measure to reduce damage to the ozone layer and mitigate risks. It has the boiling range of -40°C
- Butane – Butane is typically used as fuel for cigarette lighters and portable stoves. It is extensively used as a propellant in aerosols, a heating fuel, a refrigerant, and in the manufacture of a variety of similar

products. Butane is also found in LPG. It has the boiling range of -12 to -1°C

- Petrol – It is also known as gasoline and is used as fuel for internal-combustion engines. It finds use as a solvent for preparation of oils and fats. It is highly preferred to be used as an automobile fuel because of its high energy of combustion and capacity to mix readily with air in a carburettor. It has the boiling range of -1 to 110°C.
- Jet fuel – Jet fuel is used to power the turbine and piston engines that keep jets and other aircraft in the sky and flying safely. It has the necessary octane level to power large, powerful engines that conventional petrol lacks. It has the boiling range of 150 to 205°C
- Kerosene – Kerosene is used mainly for burning in kerosene lamps and domestic heaters or furnaces, as a fuel or fuel component for jet engines, and as a solvent for greases and insecticides. It has the boiling range of 205 to 260°C
- Fuel oil – Fuel oil is also known as furnace oil. Fuel oil mainly consists of residues from crude-oil distillation and is used primarily in steam boilers of power plants, onboard ships and in various industrial plants. Fuel oils are also usually are blended with other petroleum fractions to produce the desired viscosity and flash point according to requirements to meet the suitability criteria. It has the boiling range of 205 to 290°C
- Diesel fuel - Diesel engines are used in trucks, trains, boats, and barges and most transport for fuel. Diesel engines are used in construction equipment and machinery to lift beams, dig foundations, drill wells etc. Diesel as a fuel is also less flammable and less explosive than other fuels. Diesel engine generators use diesel as a fuel for electricity generation. It has the boiling range of 260 to 315°C.

Crude oil has certain other derivatives that are basically the resultant hydrocarbons produced when mixed with other non-hydrocarbons to create other end products like the following –

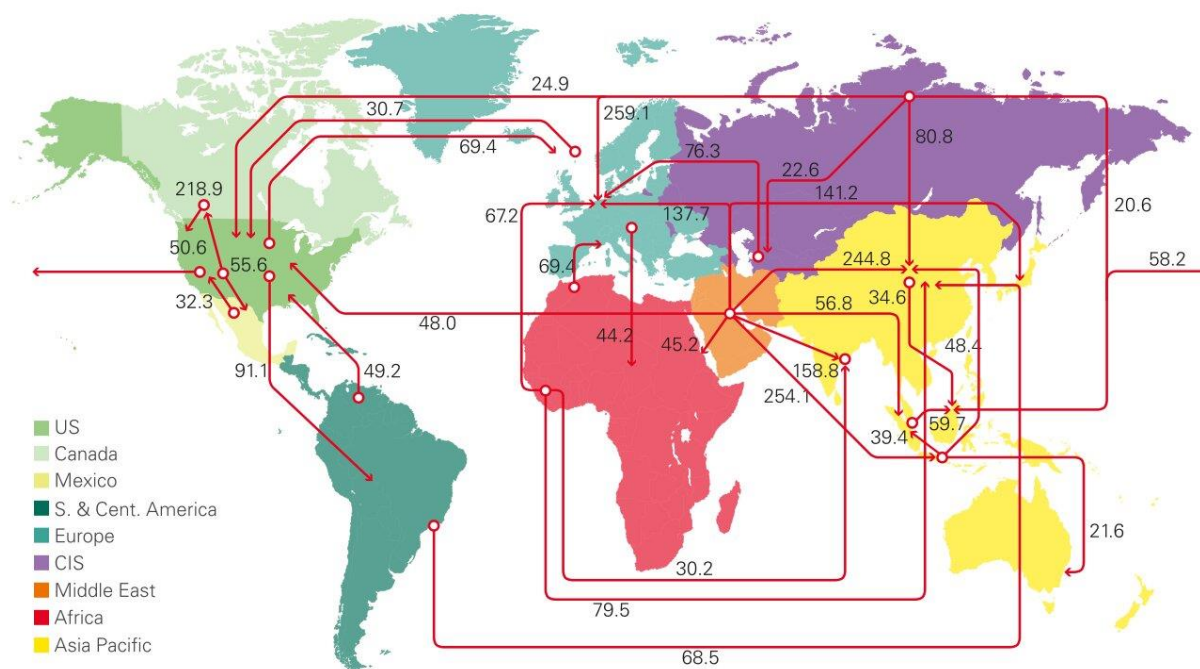
- Alkenes (olefins), which can be manufactured into plastics or other compounds
- Lubricants (produces light machine oils, motor oils, and greases, adding viscosity stabilizers as required)
- Wax, used in the packaging of frozen foods, among others
- Sulphur or sulfuric acid. These are useful industrial materials. Sulfuric acid is usually prepared as the acid precursor oleum, a byproduct of sulphur removal from fuels.
- Bulk tar
- Asphalt
- Petroleum coke, used in speciality carbon products or as solid fuel
- Paraffin wax
- Aromatic petrochemicals to be used as precursors in other chemical production

3.2.5 Trade

Over 62% the bulk of crude oil transported using seaborne trade using tankers which follows very specific routes and is constrained by strategic

passages and chokepoints. The Persian Gulf is a major source of oil and exports heavily, this is shipped by maritime transportation, with maritime routes reaching Europe through the Suez Canal, China, Japan, and South Korea, through the Strait of Malacca and North America through the Cape of Good Hope. Russian oil exports advance through the strait of Oresund, predominantly towards European markets. Since the number of significant producers across the Pacific is very less, oil trade across this region is limited. The US gets most of the Mexican oil exports. Indonesia is no longer a significant oil exporter.

Movements across the continents that were crucial include Russian movement and former Soviet Republic's petroleum being shipped to Europe by pipeline. Shipment of petroleum from Alaskan and Canadian petroleum to the US by pipeline was also major. Other important movement include that from Africa to North America and Europe, and also from South America to North America and the North Sea to Europe.



Source: <https://www.bp.com/en/global/corporate/energyeconomics/statistical-review-of-world-energy/oil.html>

Figure 3.7 – Major trade movements 2019 – trade flows worldwide
(million tonnes)

Highest worth (in \$) of Crude oil exported by 15 countries during 2019 are as shown below:

- Saudi Arabia: US\$133.6 billion (13.3% of exported crude oil)
- Russia: \$121.4 billion (12.1% of exported crude oil)
- Iraq: \$83.3 billion (8.3% of exported crude oil)
- Canada: \$68.1 billion (6.8% of exported crude oil)
- United Arab Emirates: \$66.1 billion (6.6% of exported crude oil)
- United States: \$65.3 billion (6.5% of exported crude oil)
- Kuwait: \$42 billion (4.2% of exported crude oil)
- Nigeria: \$41 billion (4.1% of exported crude oil)
- Kazakhstan: \$33.6 billion (3.3% of exported crude oil)
- Angola: \$32.3 billion (3.2% of exported crude oil)
- Norway: \$28.8 billion (2.9% of exported crude oil)
- Libya: \$24.8 billion (2.5% of exported crude oil)
- Brazil: \$24 billion (2.4% of exported crude oil)
- United Kingdom: \$23.7 billion (2.4% of exported crude oil)
- Mexico: \$22.6 billion (2.2% of exported crude oil)

By value, the listed 15 countries shipped 86.7% of globally exported crude oil in 2019.

Highest worth (in \$) of Crude oil imported by 15 countries during 2019 are as shown below:

- China: US\$238.7 billion (22.6% of overall imported crude oil)
- United States: \$132.4 billion (12.5% of overall imported crude oil)

- India: \$102.3 billion (9.7% of overall imported crude oil)
- Japan: \$73.1 billion (6.9% of overall imported crude oil)
- South Korea: \$70.2 billion (6.6% of overall imported crude oil)
- Netherlands: \$46.4 billion (4.4% of overall imported crude oil)
- Germany: \$40.7 billion (3.9% of overall imported crude oil)
- Spain: \$30.5 billion (2.9% of overall imported crude oil)
- Italy: \$29.6 billion (2.8% of overall imported crude oil)
- United Kingdom: \$24.5 billion (2.3% of overall imported crude oil)
- France: \$24.4 billion (2.3% of overall imported crude oil)
- Singapore: \$24.2 billion (2.3% of overall imported crude oil)
- Thailand: \$22.3 billion (2.1% of overall imported crude oil)
- Taiwan: \$21.3 billion (2% of overall imported crude oil)
- Belgium: \$18.8 billion (1.8% of overall imported crude oil)

The above fifteen countries purchased a total of 85.2% of crude oil imports in 2019 on the basis of total cost.

The crude oil and petroleum product imports makes India the fourth largest consumer and net importer of oil related products. One the major drivers for this demand was the transportation industry. Despite having an onshore production volume of over 17 million metric tons in 2017, the crude oil import volume into the country increased by over five percent that year. The government aimed to cut the oil imports dependence by more than 60 percent by the year 2022. However, owing to ageing fields and competition from outside, domestic production had fallen. The policies and initiatives failed to give satisfactory results henceforth.

3.2.6 Transportation

Crude oil movements are through majorly through maritime transportations using tankers. Crude oil uses very large tankers generally called oil tankers and are used because larger ships tend to be used more for crude oil as they reduce the cost per barrel of transport of the oil and help achieve economies of scale; whereas is by-products or refined petroleum products utilize smaller tankers known as product tankers. ULCC, VLCC, Suezmax, Aframax and Panamax are used for crude carriage. Over land oil can be transported via rail on special tanker cars and as well us trucks with cylindrical tanks.

In India the ports dealing with crude oil imports are – Deendayal, Mumbai, New Mangalore, Cochin, Paradip, Chennai, Visakhapatnam



Figure 3.8 – Crude oil tanker

3.3 ECONOMY OF INDIA

The growth of the Indian economy was at a slow pace of 3.9% during the first forty years post-independence. This was slow due to its transition from princely states to the adoption a democracy with a semi-socialist development model. This was hindered by excessive economic control and lack of infrastructure – socially, physically, economically and to a certain extent even politically. However, it must be put into perspective that it does not mean India had no progress – the Green Revolution, White revolution, 5 year plans for various infrastructural developments etc.

It is in the 1990s when India opened up and introduced various policies that favoured Liberalisation, Privatisation and Globalisation it soared to rise and become the 12th largest economy in the world. India had achieved a 5.5% growth rate in this decade with its per capita income rising at a rate of 4%.

With the onset of 2012 India entered a period of reduced growth, which slowed to 5.6%. Other economic problems also started cropping up and causing a hole in the Indian economy which had been having a rising phase. Some of these problems were a plunging Indian rupee crashing against the US dollar and devaluation, a persistently high current account deficit and slow-paced industrial growth to name a few.

India started recovery in the financial year of 2013–14 when the GDP growth rate accelerated to 6.4% from the previous year FY 2012-2013 5.5%. The acceleration continued through 2014–15 and 2015–16 with growth rates of 7.5% and 8.0% respectively with India reaching its all-time high. For the first time since 1990, India was growing at pace much faster than that of China's which had registered 6.9% growth in 2015. However,

the growth rate subsequently decelerated to 7.1% and 6.6% in 2016–17 and 2017–18 respectively. This can be attributed to the disruptive effects caused by the demonetisation of the Indian currency notes and the Goods and Services Tax (India) implementation in a rather botched-up manner.

The economic impact of the COVID-19 pandemic in India has been largely disruptive adding to its existing woes of a crashing economy. India's growth in the fourth quarter of the fiscal year 2020 went down to 3.1% according to the Ministry of Statistics which was the lowest every since the 1990s reforms.

NITI Aayog refers to an update provided by S&P Global in its recent update for the Indian economy projected a 10% y/y growth in FY 2021-22. It mentioned that consistently good agriculture performance, flattened coronavirus infection curve and government spending have all supported economic recovery.

Recently, a Goldman Sachs report hat state that the BRIC countries that is Brazil, Russia, India and China were poised for growth in the next 50 years and would collectively play a much more forceful and assertive role in the world's GDP and economy. There is the possibility of India becoming the world's 3rd largest economy in these 50 years to come.

3.4 INDIA'S FISCAL DEFICIT AND GROSS DOMESTIC PRODUCT

The difference between the revenues and expenditures of a government is the fiscal imbalance of the government's nation. Government of a country generally has two types of revenue in its budgetary plan, one is tax and another is non-tax revenue which includes duties, fees etc. Government

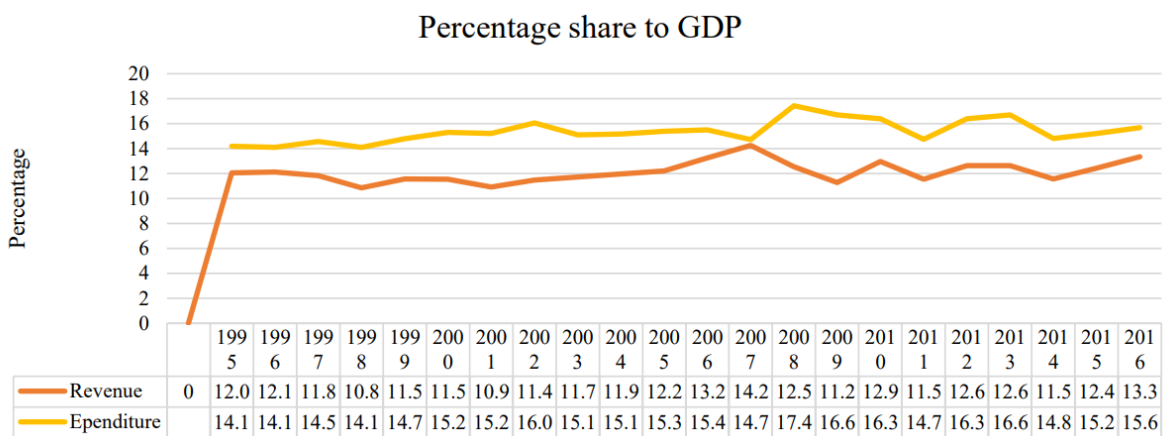
expenditures of a country include a variety of things like material consumption of the public sector, salaries of government employees, depreciation of fixed national capital, various types of transfer to the population etc. The total revenue and expenditure of the government seldom coincide. The difference between the two is the negative fiscal imbalance or the positive fiscal imbalance, which is called the budget deficit or surplus, respectively depending on which is higher – revenue or expenditure. When the fiscal imbalance is positive, it means that government revenue exceeds the costs that seem to benefit the economy. On the other hand when expenditure exceeds the revenue, negative imbalance is witnessed which when severe can pose a serious problem for the economy. Increasing of the expenditure means that government requires loan from domestic or foreign financial institutions as the government does not have enough income to prepay its obligations. This will ultimately put undue cascadingly increasing pressure on the country's economic stability. In India, the fiscal deficit in recent years has been a cause for concern because India's economy has been in constant deficit. Therefore, there is a fear that high fiscal deficit will negatively affect the country's economic growth.

Gross domestic product (GDP) is a monetary measure of the market value of all the final goods and services produced in a specific time period. The total GDP of a country is broken down into the contribution of each industry or sector of the economy. The ratio of GDP to the total population of the region is the per capita GDP and the same is called Mean Standard of Living and are also used as indices of economic development and welfare.

India's GDP has been increased after liberalization policies. In 1995 the GDP of India was 11.92 trillion rupees that it increased to 151.84 trillion rupees, that was an increase of 1174 percent. That shows India is economy

is increasing as it mentioned above too. Besides, the total GDP of India from 1995 to 2016 was around 1249.54 trillion rupees.

In 1995, the fiscal deficit of India was -0.26 trillion rupees that it increased to -3.54 trillion rupees of 2016. This means that the fiscal deficit of India in 21 years had increased by 1244.76 percent.



Source – *India’s Fiscal Deficit and its Impact on Gross Domestic Product: An Analysis by Mohammad Haroon Ahmadi*

Figure 3.9 – India’s Government revenue and expenditure percent share to GDP since 1995

Ahmadi (2021) explains in his study that from 1995 to 2016 the GDP and fiscal deficit with its parts had experienced increased growth in their amount. Fiscal deficit was found to have a negative impact on the economic growth of the countries in some papers but in some other studies fiscal deficit was found to have a positive impact on the GDP growth of the countries. Ahmadi (2021) used a regression model to study further this aspect to conclude whether GDP and fiscal deficit affect each other in the period 1995 to 2016.

Ahmadi (2021) concludes that fiscal deficit does not have effect or influence on the GDP of India in that period of time and it just put 4.1 percent impact on GDP growth of India. It can be concluded further that the impact of fiscal deficit on GDP growth of India was not much and the relationship between these two variables was a no significant relationship.

CHAPTER IV

ANALYSIS AND INTERPRETATION

4.1 METHODOLOGY USED

This study is a research and was conducted on the basis of a certain research methodology. Research methodology refers to the specific processes, procedures, techniques or even implementing certain software tools with an aim to conduct research. There is a methodology involved in every aspect of the research. It begins with identification of a particular topic, its selection followed by the search and collection of data, processing it with a particular set of objective framework and finally analyzing the results obtained after the processing. This analysis is backed by a set of concrete facts, previous research literature work pertaining to the field, the researcher's interpretation and providing direction to a scholar or potential researcher in the domain of the topic.

This research aims at studying the trend of imports of coal and crude oil and the impacts of these imports over the years period between 2010 to 2020 on the Indian economy. Due limitations and constraints with the current pertaining COVID-19 scenario had to be based on secondary data sources. For the background study various research papers and articles were collected and thorough reading of the same was done to have various inputs from researches conducted prior to this. As for data collection, secondary data as published by various departments of the Government of India were taken. The details of import of coal were obtained from the Ministry of Coal, Government of India. Data regarding the import of crude oil were obtained and Petroleum Planning and Control, Ministry of Petroleum and Natural Gas, Government of India. For analysing the impact on the economy, the metrics taken into consideration was Fiscal deficit of

India from the Reserve Bank of India's Data base of Indian Economy also known as RBI's Data Warehouse.

The data obtained was thoroughly analysed and tabulated as per the requirement of the research. It was decided that the researcher would use regression analysis to find the impact of the imports of coal and crude oil on the fiscal deficit of India, as fiscal deficit is a measure that is the difference between expenditure and revenue of the nation and imports increase expense of a nation. The regression analysis was conducted on Microsoft Excel using the Regression function for data analysis. The fiscal deficit in crore rupees was selected as the dependent variable whereas total coal import in metric tonnes and total crude oil import in metric tonnes were selected as the independent variables.

Regression Analysis is a quantitative research methodology which is ideally used when there is analysis of several parameters or variables and where there is a relationship that involves a dependent variable and one or more than one independent variables. The nature, strength and character of the relationship between these variables is evaluated through regression analysis. It is basically a modelling and analysis framework. This theory can be put into equation form as given below.

Let,

- Y_i = dependent variable
- f = function
- X_i = independent variable
- β = unknown parameters
- e_i = error terms

Then,

$$Y_i = f(X_i, \beta) + e_i \quad (\text{equation 4.1})$$

A regression analysis incorporates variations depending on the relationship. This can be categorised as simple linear regression, multiple linear regression and nonlinear regression. Simple linear regression and Multiple linear regression are the most widely and frequently used regression models whereas the nonlinear regression analysis is preferred in cases where the data sets taken for analysis are more complicated and establishing a relationship is more complex and can not be visualised in linear models.

The linear regression model is based on certain fundamental assumptions which are –

1. The dependent and independent variables show a linear relationship between the slope and the intercept.
2. The independent variable is not random.
3. The value of the residual error is zero.
4. The value of the residual error is constant across all observations.
5. The value of the residual error is not correlated across all observations.
6. The residual error values follow the normal distribution.

Simple linear regression model basically evaluates the relationship between a dependent variable and an independent variable. This concept is statistically expressed in equation form as –

$$Y = a + bX + e \quad (\text{equation 4.2})$$

Where,

- Y = Dependent variable
- X = Independent variable
- a = Intercept
- b = Slope
- e = Residual error

Here, the values of intercept a and slope b are determined by the following formulae

Where,

y and x = these are the data sets

n = number of observations or sample size

$$a = \frac{\sum y - b \sum x}{n} \quad \text{(equation 4.3)}$$

$$b = \frac{n \sum xy - (\sum x)(\sum y)}{n (\sum x^2) - (\sum x)^2} \quad \text{(equation 4.4)}$$

The multiple linear regression analysis model is similar to the single linear regression analysis model. Like the simple linear regression model, the multiple linear regression model has one dependent variable. However, the difference lies in the fact that there are multiple independent variables. This concept can be better expressed in its statistical equation form as –

$$\mathbf{Y = a + bX_1 + cX_2 + dX_3... + e} \quad \text{(equation 4.5)}$$

Where,

- Y = Dependent variable
- X_1, X_2, X_3 = Independent variable
- a = Intercept
- b, c, d = Slopes
- e = Residual error

To conduct a multiple linear regression analysis manually is a tedious task and this problem can be made easier by using software tools. For this research Microsoft Excel was used. The data analysis tool pack can be installed and has a variety of analysis tools like Correlation, Covariation, Fourier Analysis etc. The regression option can be selected which opens a window as shown in Figure 4.1. The dependent variable can be entered into the 'Input Y Range' and the independent variables can be entered into the 'Input X Range' and the confidence level can be set, by default which is at 95% and the output options maybe specified to obtain the regression analysis results.

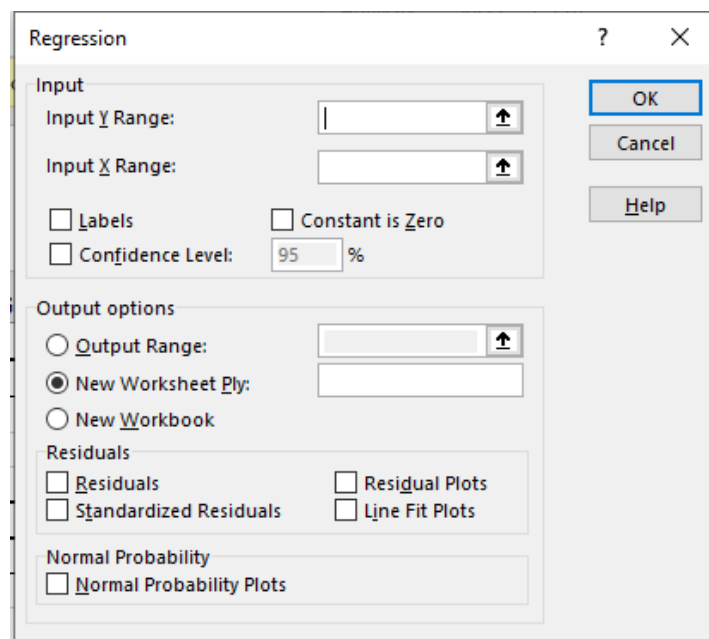


Figure 4.1 – Regression Analysis window on Microsoft Excel

The results obtained is analysed and the regression equation is obtained which is analysed and inferred from.

4.2 ANALYSIS OF THE STUDY

4.2.1 Regression Analysis

The following table is the tabulated version of the data required for the regression analysis. The period of 10 years was selected lasting from the financial year of 2010-2011 till 2019-2020.

Data regarding the import of coal was obtained from the website of the Ministry of Coal, Government of India. The data had details of imports by quantity (in million metric tonnes) and in terms of value (in million rupees) as seen in Table A in Annexure. The Total Coal Quantity as seen in Table 4.1 was calculated as a sum of import quantities of coking coal, non-coking coal, coke and other coal products and lignite imported.

Data regarding crude oil was obtained from the website of the Petroleum Planning and Control, Ministry of Petroleum and Natural Gas, Government of India. The data had details of imports by quantity (in metric tonnes) and in terms of value (million USD as well as crore rupees) as seen in Table B in Annexure. The Total Crude Oil Quantity as seen in Table 4.1 was calculated as a sum of import quantities of Crude Oil and Crude oil products like LPG (liquefied petroleum gas), MS (Motor Spirit), Naphtha, ATF (automatic transmission fluid), SKO (superior kerosene oil), HSD (high speed diesel), LOBS (Lubricating oils), Fuel oil, Bitumen and others.

The Fiscal deficit of India from the Reserve Bank of India's Data base of Indian Economy also known as RBI's Data Warehouse.

Here the Dependent variable that was selected is Fiscal Deficit in Crore Rupees. The independent variables selected are the Total Coal Quantity in million MT and the Total Crude Oil Quantity in MT.

Table 4.1 – Data Set for Regression Analysis

Year	Total Coal Quantity (million Mt)	Total Crude Oil Quantity (Mt)	Fiscal Deficit (Crore Rupees)
2010-11	70.40781	180974	534032
2011-12	105.21732	187579	684966
2012-13	148.86674	201149	684395
2013-14	171.02883	205935	749711
2014-15	221.07732	210737	836563
2015-16	207.02194	232306	952410
2016-17	195.31865	250220	1064704
2017-18	212.84386	255894	997097
2018-19	240.29832	259846	1102729
2019-20	251.46538	270742	1408183

On conducting the regression analysis, regression statistics were obtained as shown in table 4.2 and the Intercept and Coefficients of Variables 1 and 2 were obtained as shown in table 4.3. Here, 'X Variable' 1 denotes Import of Coal and 'X Variable 2' denotes Import of Crude Oil which helps arrive at the regression equation.

Table 4.2 –Regression Statistics obtained from Regression Analysis

Regression Statistics	
Multiple R	0.9526067
R Square	0.907459525
Adjusted R Square	0.881019389
Observations	10

Table 4.3 –Regression Equation Coefficients

	Coefficients
Intercept	-677325.5453
X Variable 1	679.7133433
X Variable 2	6.450594714

The Regression Equation obtained is of the form –

$$y = a + b_1x_1 + b_2x_2 \quad (\text{equation 4.6})$$

Where,

y = Fiscal Deficit of India in Crore Rupees

b_1 = slope which is the coefficient of Total Quantity of Coal and Coal Products imported in million metric tonnes

x_1 = Total Quantity of Coal and Coal Products imported in million metric tonnes

b_2 = slope which is the coefficient of Total Quantity of Crude oil and Crude oil Products imported in metric tonnes

x_2 = Total Quantity of Crude oil and Crude oil Products imported in metric tonnes

Thus, the regression equation obtained is –

$$y = - 677325.545 + 679.713x_1 + 6.451x_2 \quad (\text{equation 4.7})$$

4.2.2 Trend Analysis

The trend analysis for imported quantity of coal showed a linear increase throughout the years between 2010-11 and 2019-2020 as shown in Figure 4.2. A similar trend was observed that is a linear increase of quantity of imported coal in the same period. The fiscal deficit curve also matches and is comparable to the increasing trend of imports during this period. This

indicates that all three – imports of coal, imports of crude oil and fiscal deficit seem to be exhibiting similar trends.

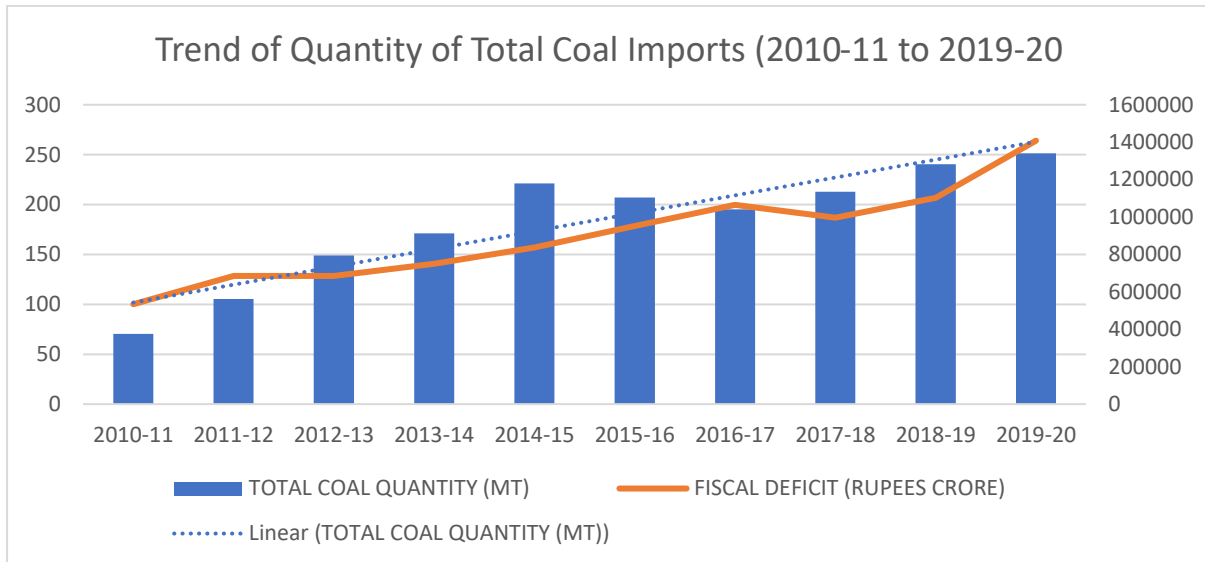


Figure 4.2 – Trend of Quantity of Total Coal Imports

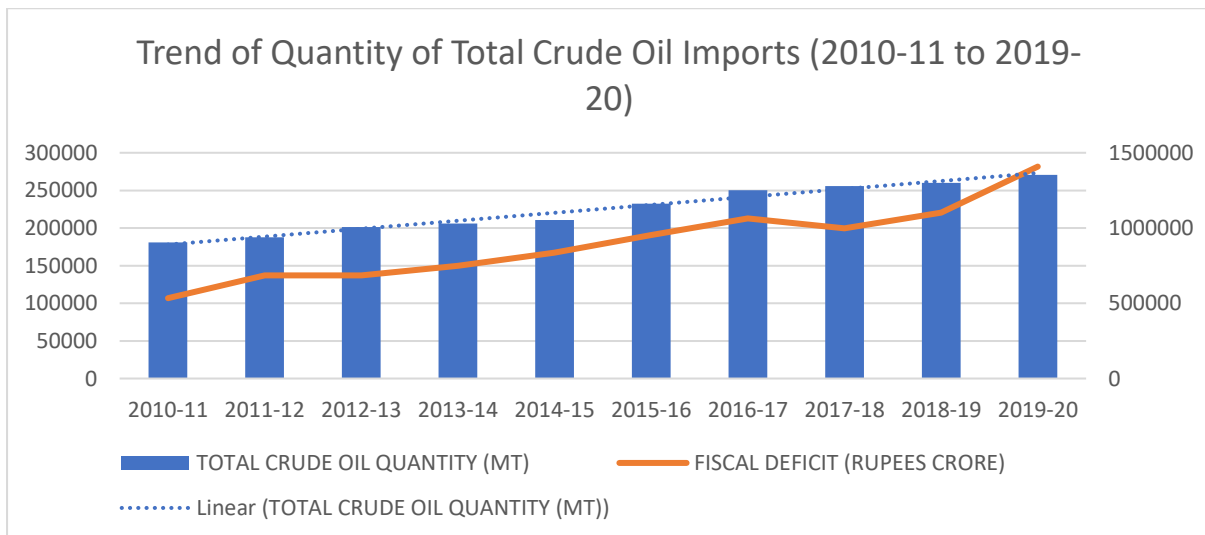


Figure 4.3 – Trend of Quantity of Total Crude Oil Imports

4.3 INTERPRETATION OF THE STUDY

The first part of the result contains the goodness of fit measures which indicates to what extent the calculated regression equation fits the data set chosen for the analysis.

- Multiple R is the correlation coefficient it indicates how strong the linear relationship is, and if it is closer to 1 then it indicates a positive relationship and if it is towards 0 then there exists no relationship. The obtained correlation coefficient was 0.9526067 which is very close to one and indicates a strong positive linear relationship between Fiscal deficit, Total quantities of coal and crude oil imported respectively.
- R^2 is the coefficient of determination and gives indication on how many plot points fall on the line of regression. Here, the coefficient of determination was observed to be 0.907459525 which is 90.75% approximately which means that 90.75% of the points align with the regression equation or in other words 90.75% of the variation of the y values (fiscal deficit) around the mean are explainable by the independent x values (import quantities of coal and crude oil).
- Adjusted R^2 adjusts for the number of terms that are taken into consideration for the model, in this research we have 10 terms and the adjusted R^2 was found to be 0.881019389 which is approximately 88.1%. This value is more preferred than the R^2 value as this incorporates the number of terms and is more suited for multiple linear regression model.

From this it can be interpreted that all these three measures of goodness of fit indicate that the multilinear regression equation fits the collected data set well.

The multiple linear regression equation that was obtained was –

$$y = - 677325.545 + 679.713x_1 + 6.451x_2$$

Where,

y = Fiscal Deficit of India in Crore Rupees

b_1 = slope which is the coefficient of Total Quantity of Coal and Coal Products imported in metric tonnes

x_1 = Total Quantity of Coal and Coal Products imported in million metric tonnes

b_2 = slope which is the coefficient of Total Quantity of Crude oil and Crude oil Products imported in metric tonnes

x_2 = Total Quantity of Crude oil and Crude oil Products imported in metric tonnes

From this equation we can interpret the following –

- When there is an ideal case of no imports of coal and crude oil in India there will be a fiscal deficit of –677325.545 Crore Rupees or rather a surplus of 677325.545 Crore Rupees.
- For every one unit of increase of total quantity of coal imported the fiscal deficit will rise by 679.713 Crore Rupees.
- For every unit of increase of total quantity of crude oil imported the discal deficit will rise by 6.451 Crore Rupees.

When we look at the trend of import of coal and crude oil quantities it can be seen to increase in this 10-year period.

When we consider the Figure 4.2, the base year 2010-11 the total import of coal is 70.40781 million metric tonnes and has risen to a whopping 251.46538 million metric tonnes in 2019-20 which is a rise of over 257.16%. The coal imports increased greatly from 2010-11 to 2014-15 which is highest rate of increase in this decade approximately 214%; after which there was a decline in 2015-16 and a further dip in 2016-17 of around 11.65%. There was a slight rise of 8.97% following this however had not reached the 2014-15 levels. This was eventually recovered in 2018-19 and the following year. In the last 10 years 2019-20 recorded the highest import quantity.

If we consider the Figure 4.3, it can be seen that the base year 2010-11 the imports of crude oil is at 180974 metric tonnes. This quantity continues to rise through out the years with no decline till a value of 270742 metric tonnes in 2019-20. This is almost 49.6% increase in this last decade. The trend line follows a linear equation

CHAPTER V

CONCLUSION

5.1 FINDINGS OF THE STUDY

This study was comprehensive study on the impact of importing of coal and crude oil on fiscal deficit and thereby the impact on economy of India. It was seen that the import of coal and crude oil has an impact on the fiscal deficit and it was seen to increase as the imports increased. They exhibited a positive correlation. The equation indicated a possibility of a trade surplus if imports of crude and coal were likely to be stopped (When there is an ideal case of no imports of coal and crude oil in India there will be a fiscal deficit of -677325.545 Crore Rupees or rather a surplus of 677325.545 Crore Rupees.) and that for every unit of increase of coal in million metric tonnes and crude oil in metric tonnes this will cause an increase in the fiscal deficits (For every one unit of increase of total quantity of coal imported the fiscal deficit will rise by 679.713 Crore Rupees. For every unit of increase of total quantity of crude oil imported the fiscal deficit will rise by 6.451 Crore Rupees). When depicted as graphs it was analysed that all three the fiscal deficits and the import quantities have a linearly increasing trend. It can be said that the imports of coal and crude impacts the fiscal deficit by increasing which is not healthy for the economy. Fiscal deficit is always a point of concern for economies especially when in the developing phase like India, high fiscal deficits indicate that the expenditure of India is higher than the revenue that is generated. Coal and Crude oil are requirements are also high in India which as seen the reserves cannot cater to the demand and hence the constantly increasing trend in import quantities.

5.2 SUGGESTIONS

The fiscal deficit is on constant rise and the research has established a strong relationship between the coal and crude oil import quantities with the fiscal deficit. Thus, this increase in import trend must be reduced. India has too much import dependency with respect to the coal and crude oil. Coal and crude oil are necessary for economic development however there needs to be a balance.

Based on this study the researcher proposes to put forward the following suggestions –

- More exploration activities to identify coal and crude oil reserves and accurate and precise assessments through advanced technologies and skilled work force.
- Optimum utilization of existing coal and crude oil reserves of India with implementing practices, principles, equipment and technology to avoid wastage in all processes from exploration, collection, processing to final distribution.
- India's coal imports and coal obtained from reserves go into thermal power plants primarily, this is mainly for electricity generation. There must be more extensive researches into adopting renewable resources for energy rather than opting for coal-based energy. Solar, wind, hydel, geothermal and biomass energy forms. This is a capital intensive yet much needed move as it has multiple benefits
 - Reduced use of coal there by reducing import dependency and bringing down fiscal deficit, also improving India's trade balance
 - Reserves lasting longer and not running out of coal as a resource
 - Environmentally more friendly and sustainable as renewable resources of energy are cleaner

- Lesser chances of disruption as renewable resources are readily available, lesser chances of facing demand-supply gap issues or at least lesser in severity.
- Indian imports of crude oil are for internal usage as well as re-exporting as POL products, hence despite the expenditure there is a source of revenue after value addition. However, if crude oil reserves are more optimally used with better exploration technologies and minimizing wastages certain quantities can be reduced helping reduce imports.
- For crude oil as well, demand can be lowered by opting for renewable resources. As the population increased there has been a considerable increase in private vehicles leading to more congestion, pollution and all-time high consumption of petrol and diesel, initiatives are being undertaken to promote electric vehicles and even CNG vehicles. This must be further entertained and common public must be aware of the same. Gujarat has introduced 'Gujarat Electric Vehicle Policy 2021' recently providing subsidies to the public to encourage this motion. This switch over will bring down extensive demand for petrol and diesel there by reducing demand for the crude oil and thus reduce import dependencies. Also, it helps achieve environment sustainability.

Ultimately the goal is to reduce import dependencies to have a stable economy, at the same time meet needs and demands without hindering the growth and development of the nation and the ideal solution is to switch to alternate resources which are also environmentally sustainable. This is possible only when –

- There is proper policy framework in support of the motion – the initiative for this must come from the Government of India, by the Ministry of Coal, Ministry of Petroleum and Natural Gas, Ministry of Power and also the Ministry of New & Renewable Energy on the national level.

- Support of the State governments and initiatives to encourage the same.
- Public awareness of switching to options where renewable energy resources are utilized for domestic needs and minimizing use of coal and crude oil
- Industrial uses of coal and crude oil is plenty, wastages must be reduced through waste audits, and using of alternate energy resources wherever possible.
- Better stakeholder integration for an optimal energy mix for the nation

5.3 CONCLUSION

Fossil fuels like Coal and Crude oil are resources that have extensively been part of the industrialisation period and the era's that have followed. These resources have been used widely across the world as part of their development processes. Even currently, irrespective of the phase of development be it developed countries, developing countries or even less developed countries, all these countries do require and depend on fossil fuels to meet their powering, fuelling and even in the manufacturing industry. But not all nations are self-sufficient possessing all the required resources in quantities to meet their demands. Trade facilitates this.

Very much pertinent to this concept of trading fossil fuels like coal and crude oil, while considering imports have a major impact on the economy. Despite the vitality of such resources that facilitate processes that help attain economic development and economic growth, there is tremendous expenditure when it comes to such resources. The market rules the prices and due to its high demand and competition between developing and developed countries, and also the export countries having a high upper hand especially the OPEC countries involving the Persian Gulf, there is a lot that importing countries have to consider. There comes the necessity of

balancing the imports maintaining the economy and not cutting a hole in nation's economy or wealth at the same time acquiring resources of quality and in time to sustain, maintain and develop their nation.

In this research this has been evaluated from the perspective of India. It has been understood that, there is a strong influence of coal and crude oil imports on the fiscal deficit, which is understandable as such hefty exports do increase the expenditure of the country.

There is the other aspect of the excessive utilisation of these resources deplete the resources which are non-renewable and exhaustible. There is a finite amount that can be utilized and if not used judiciously there will come times where such resources will not be available. The concept of sustainable development is to be considered here. Moreover, it is of concern that when coal and crude oil are used in various faculties, the reactions they undergo often end up polluting nations and the world as a whole – right from causing the AQI index to be unfavourable to global warming and climatic change the harmful effects have been on the rise. Here again is where we have to realize the consequences and switch over or adapt to renewable resources of energy – both to avoid over utilization and depletion of the resources as well as to sustain the environment. Also, this would help reduce import dependency on these materials bringing down the expenditure and help reducing the fiscal deficit and bring the nation closer to achieving the dream of fiscal surplus.

In the Indian context, the fossil fuel industry in India is most likely to face competition from renewable energy sources like solar, wind, thermal, biomass and nuclear energy in the near future with the formation of the Ministry for New and Renewable Energy started in 2015. The Maritime Vision 2030 which came out in 2021 February projects coal and crude oil

imports to increase till the financial year of 2030 due to lack of possible exploration or discovery of more resources in India, which is a point of concern especially coal, as most of India's coal consumption to meet its domestic needs. Crude oil on the other hand is refined in India and is a strong export commodity of India's and is a value addition activity. The union minister for Coal and Mines, Mr. Pralhad Joshi did give the statement on India considering to stop coal imports from the financial year of 2023-24, however this is a move to be pondered.

The efforts must be directed at achieving a balanced and sustainable energy mix which not only underlines the significance of resources like coal and crude oil for the economy, but promote the concept of optimal usage wherever necessary rather than ban imports. An efficient energy mix of renewable and non-renewable resources is vital to maintain or reducing the fiscal deficit and thereby the economy also without hindering the rate and pace of economic growth and development, rather it must help boost it. All stakeholders must be on the same page and better integrated to assess, evaluate the situation and better it.

5.4 DIRECTION FOR FUTURE RESEARCHER

This research was limited in its scope to a data of a 10-year period between 2010-11 and 2019-20. The scope can be expanded to a 20-25 year span research work to analyse the trend and also project into the future. Also, instead of restricting to one parameter that is the fiscal deficit the economy of India can be analysed through more factors, like GDP. In this present study GDP was not accommodatable as the theoretical results expected to be seen were not as expected and the limitation is due to the narrowing down of the scope. However, it was seen Ahmadi (2021) concluding that Fiscal Deficit and GDP have no significant relationship, this has always been debatable. Coal and Crude oil trend projections for the future as well as

the utilisation of renewable resources may also be incorporated into the same. Also another possible direction of research is to find the impact / feasibility of reducing imports of crude and coal or rather researching on finding the perfect energy mix in order to achieve economic stability as well our sustainable goals and at the same time boost our economic development, growth and meet all energy requirement demands.

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ANNEXURE

Table A – Import of Coal

Quantity in Million Tonne & Value in Million Rs

YEAR	COKING COAL		NON COKING COAL		TOTAL COAL		COKE & OTHER COAL PRODUCTS		LIGNITE		TOTAL COAL (Including Coking, Non-Coking, Coke, Products and Lignite)	
	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	Quantity	Value
2010-11	19.48392	208620.70	49.43368	206875.09	68.9176	415495.79	1.49021	31203.55			70.40781	446699.34
2011-12	31.80101	424692.34	71.05162	363683.49	102.85263	788375.83	2.36469	47584.54			105.21732	835960.37
2012-13	35.55697	378398.09	110.22847	490056.94	145.78544	868455.03	3.08065	56918.82	0.00065	10.22	148.86674	925384.07
2013-14	36.87214	348318.65	129.98489	574973.16	166.85703	923291.81	4.17053	67994.89	0.00127	23.73	171.02883	991310.43
2014-15	43.71529	337655.59	174.06751	707410.50	217.7828	1045066.09	3.29388	43806.15	0.00064	17.03	221.07732	1088889.27
2015-16	44.56117	282519.09	159.38809	577818.53	203.94926	860337.62	3.07163	32683.54	0.00105	14.83	207.02194	893035.99
2016-17	41.64379	412300.61	149.30926	590013.33	190.95305	1002313.94	4.34648	54019.35	0.01912	433.29	195.31865	1056766.58
2017-18	47.00325	595226.36	161.24542	789543.41	208.24867	1384769.77	4.58478	91524.74	0.01041	116.5	212.84386	1476411.01
2018-19	51.83768	720497.64	183.51033	988707.26	235.34801	1709204.90	4.93094	120644.85	0.01937	403.43	240.29832	1830253.18
2019-20	51.83275	612668.32	196.70383	914652.23	248.53658	1527320.55	2.87455	60256.67	0.05425	1074.46	251.46538	1588651.68

Table B – Import of Crude Oil

QTY in '000 Metric Tonnes, USD in 'Million US Dollars, INR in Rupees 'Crore

YEAR	PRODUCT																											TOTAL PRODUCT IMPORT					
	LPG			MS			NAPHTHA			ATF			SKO			HSD			LOBS/LUBE OIL			FUEL OIL			BITUMEN			OTHERS			QTY	INR	USD
2010-11	4,484	15888	3,469	1,702	6427	1403	2,063	6853	1453	0	0	0	1,381	4939	1081	1,996	6969	1505	1,291	4093	855	1,013	2455	527	98	210	43	3,352	8164	1731	17,379	55998	12,067
2011-12	5790	27019	5584	654	3311	716	2091	9827	2022	0	0	0	564	2710	597	1059	5039	1096	1434	8314	1708	1203	4392	912	78	197	40	2977	7282	1514	15,849	68091	14,189
2012-13	6301	31674	5803	147	891	160	1762	9272	1691	0	0	0	0	0	0	528	2771	507	1977	11339	2068	1038	4218	778	102	272	50	4501	8415	1534	16,354	68852	12,591
2013-14	6567	37213	6144	235	1481	248	1020	6044	982	0	0	0	0	0	0	77	452	74	2090	12985	2122	1331	5759	942	246	801	132	5130	11162	1822	16,697	75897	12,466
2014-15	8313	36571	5955	372	2301	375	1034	4592	744	140	706	114	30	172	29	124	670	108	2148	12702	2067	902	3659	599	517	1623	262	7722	11649	1885	21,302	74645	12,138
2015-16	8959	25778	3922	1012	4207	648	2931	9581	1463	286	889	135	41	158	25	177	605	92	2264	9478	1439	1170	2380	363	879	1832	279	11735	10454	1586	29,456	65362	9,952
2016-17	11097	32124	4775	476	1617	239	2777	8374	1240	338	1109	163	0	0	0	1008	2959	438	2131	8625	1276	925	1848	273	951	1638	242	16585	13271	1967	36,288	71565	10,613
2017-18	11380	37875	5849	174	581	91	2212	8161	1261	300	1159	178	0	0	0	1361	4269	660	2539	12075	1860	1213	3231	499	950	1902	293	15333	19120	2946	35,461	88373	13,637
2018-19	13235	49939	7178	670	3104	445	2082	9665	1391	259	1392	200	0	0	0	555	2486	360	2457	13349	1910	1419	4782	696	877	2149	309	11794	26798	3852	33,349	113664	16,341
2019-20	14809	50347	7070	2146	9610	1357	1662	6678	941	65	309	45	0	0	0	2796	11619	1632	2675	11869	1673	4583	11791	1650	1630	3634	510	13423	19885	2811	43,788	125742	17,689
2020-21	16527	53883	7262	1343	4903	669	1364	3442	460	0	0	0	0	0	0	658	2060	278	2134	9583	1284	6863	15350	2074	1649	2744	367	12945	13202	1765	43,481	105167	14,159

YEAR	CRUDE OILS			TOTAL PRODUCT IMPORT			TOTAL IMPORT OF CRUDE & PRODUCTS		
	QTY	INR	USD	QTY	INR	USD	QTY	INR	USD
2010-11	163595	455276	1,00,080	17,379	55998	12,067	180974	511274	1,12,147
2011-12	171729	672220	139690	15,849	68091	14,189	187579	740311	1,53,879
2012-13	184795	784652	144293	16,354	68852	12,591	201149	853504	1,56,884
2013-14	189238	864875	142962	16,697	75897	12,466	205935	940772	1,55,428
2014-15	189435	687416	112744	21,302	74645	12,138	210737	762061	1,24,882
2015-16	202850	416579	63972	29,456	65362	9,952	232306	481941	73,924
2016-17	213932	470159	70196	36,288	71565	10,613	250220	541724	80,809
2017-18	220433	566450	87803	35,461	88373	13,637	255894	654823	1,01,440
2018-19	226498	783183	111915	33,349	113664	16,341	259846	896847	1,28,256
2019-20	226955	717001	101376	43,788	125742	17,689	270742	842743	1,19,065