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ECONOMIC IMPLICATIONS OF NATURAL GAS ALLOCATION ON THE INDIAN ECONOMY

Alok Aditya* and Krishna Raj**

Abstract

This paper analyses the economic implications of natural gas allocation on the Indian economy. It explores the optimal priority order for natural gas allocations based on its economic linkages with other sectors. Using input-output modelling, the study assesses the quantitative economic impacts of natural gas on output, income, and employment in India. The backward linkage analysis revealed that the natural gas sector's high import dependency generates ₹0.357 demand from other sectors per additional rupee of output. Despite lower backward linkage scores compared to crude petroleum and coal, the natural gas sector exhibited strong forward linkages, influencing ₹1.957 across various sectors. The investment in the natural gas sector exhibited a production-induced effect of 1.357, indicating a positive impact on economy-wide output. Moreover, changes in final demand for natural gas had a notable effect on household income and employment, further showcasing the sector's significant contributions to the overall economy.

Keywords: Natural gas; Economic impacts; Input-output analysis; Sectoral interlinkages; Energy

Introduction

Natural gas is the most desirable fuel among fossil fuels due to its environmental benefits and competitive fuel efficiency. India pursues specific policies to promote this fuel in its energy basket. However, India is poorly endowed with natural gas resources. As on 01.04.2020, the total ultimate natural gas reserve under ONGC & OIL[1] (nomination) and PSC/RSC/DSF[2] regime were 2299.7 billion cubic metres (BCM), while the total balance recoverable reserves were 1080.4 BCM (MoPNG, 2021). India has a further 2600 BCM reserve of coal bed methane spread over 11 Indian states. The country fulfils almost 50% of its natural gas demand by importing natural gas from different exporter countries. To reduce import dependency, India has been implementing various reform policies and market mechanisms to enhance the production of natural gas and allocation to the needy sectors on a priority basis at affordable prices. However, until 1997, no major reform policies were implemented, and the natural gas acreages were mostly awarded to national oil companies. This resulted in a slow pace of the acre age distribution and, hence, lower natural gas production. The government introduced a New

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[1] ONGC – Oil and Natural Gas Corporation Limited and OIL – Oil India Limited are national oil and gas companies of India.

[2] PSC – production sharing contracts; RSC – revenue sharing contracts; DSF – discovered small fields.

Exploration and Licensing Policy (NELP) in 1999. It allowed both public and private companies (domestic and foreign) to participate in the exploration and production of natural gas. The NELP regime is based on production-sharing contracts (PSC), in which government and private companies can jointly produce natural gas. The allocation of gas fields under this regime were done through discoverable bidding. In 2016, the government revised its exploration and production (E&P) policy, introducing the Discovered Small Fields (DSF) regime, which uses a revenue-sharing model. The Hydrocarbon Exploration and Licensing Policy (HELP) launched in 2017 aimed to simplify regulations, offering a single license for conventional and unconventional hydrocarbons. HELP also introduced the Open Acreage Licensing Policy (OALP), allowing companies to bid on desired fields. Despite these reforms, domestic natural gas production has not significantly increased due to delays in production commencement, unfavourable market conditions, and limited private (especially foreign) company interest. In 2018-19, the P&NG sector contributed 1.98% of the country's total GVA. In 2019-20, the sales tax/VAT payment on natural gas by central and public sector enterprises (CPSEs) was ₹6909.79 crore, while GST and royalty payment (natural gas) by oil and gas companies were ₹7345.33 crore and ₹2566 crore, respectively (PNG Stats MoPNG, 2021). In the financial year 2019-20, oil and gas CPSEs employed a total of 103832 workers, of which the highest was employed in exploration and production activities (28%), followed by marketing (27.3%), refining (24.4%), and pipeline (6%), respectively.

Natural gas allocation determines the gas supply to different sectors, which comes between the transmission and distribution phases of the natural gas activities. Since India has yet to achieve a completely liberal market for natural gas, the allocation defines the sectoral supply of natural gas. A major issue is the domestic natural gas allocation policies, which are designed to address demand-supply gaps, lower prices for key consumers, and prioritize certain sectors. Initially, the priority sectors were fertilizer, power, petrochemicals, and city gas distribution (CGD), with regional allocation policies implemented for CGD to reduce pollution in cities like Delhi. Over time, the order of priority shifted to CGD, strategic sectors (atomic energy and space), petrochemicals, fertilizer, and power plants. At the same time, the natural gas market in India is transitioning from a fully regulated to a more liberalized market. This transition is driven by domestic supply development, economic reforms, and global market influences (Jain & Sen, 2011). Historically, no competitive fiscal regime existed for natural gas exploration and production. Given the capital-intensive nature of the natural gas business, private companies focus on profit maximization, optimal pipeline utilization, and competitive downstream pricing. However, government control over pricing and allocation and other regulatory barriers have deterred private investment, leading to a monopolistic market structure in production, transmission, and distribution. The pricing issue is crucial for upstream and downstream sector development (Corbeau, 2010). Indian government policies aim to harmonize natural gas pricing with environmental and social objectives, but prices are also linked to global crude oil prices beyond government control (Kar *et al*, 2017). This has resulted in a skewed market structure, with the fertilizer and power sectors consuming 70% of India's natural gas, unlike the global trend, where CGD and other industries are major consumers (Nischal & Kumar, 2008). The government has increased CGD allocation to promote clean cooking and transportation, but industrial use of natural gas remains limited, mainly as non-energy feedstock in the fertilizer sector.

However, these allocation policies were not based on the natural gas sector's economic linkages with other sectors or justified by their economic implications. The economic impact of natural gas on sectoral linkages remains underexplored. On the other hand, despite its economic importance as an important source of income and employment, there is a lack of scholarly studies on the economic impacts of the natural gas sector in India. Prior studies explain the economic impacts of natural gas coming through its consumption while missing the sectoral interplay of the demand and supply dynamics. Srinivasan *et al* (2015)explain the relationship between energy consumption, carbon emissions, economic growth, and trade in India, which is a complex interplay that underscores the importance of energy security for economic development and poverty alleviation. Similarly, Solarin and Lean (2016) and Ummalla and Samal (2019) found a bidirectional causality relationship between natural gas consumption and GDP growth in India and China, and that natural gas consumption increases further energy production, which indirectly creates employment and national income. Replacing domestic natural gas consumption with black coal can lead to adverse economic impacts(Kumar *et al*, 2020). Malyan (2020) opines that as India moves towards its ambition of a gas-based economy by 2030, more research is required to explore the long-term implications of natural gas on the creation and sustainability of new jobs. According to him, on the one hand, the increasing gas demand will lead to the expansion of infrastructure, which will increase the employment opportunity, while, on the other hand, there will be job loss due to the displacement of other fossil fuels. Malyan *et al* (2021) highlight that in the scenario of high natural gas penetration in India, the sector has the potential to generate approximately 1.2 lakh new employment as well as savings in import bills of around 723 billion. The economic impacts of natural gas extend beyond energy considerations, with implications for economic growth, ecological footprint, and overall sustainability(Adebayo *et al*, 2023; Roy, 2023).Furthermore, studies emphasize the role of natural gas in fostering environmental sustainability in India, indicating that gas consumption, along with nuclear energy and economic growth, can predict long-term ecological sustainability (Adebayo *et al*, 2023).

Given this knowledge gap, the current study provides an assessment of the economic implications of natural gas allocation for the Indian economy. This study aims to fill that gap by evaluating the economic implications of the natural gas sector on the Indian economy, focusing on sectoral output, income, employment, and value-added contributions. For this, the study applies I-O modelling to assess the quantitative economic impacts of natural gas on the output, income, and employment of the economic sectors in India.

Methodology

Choice of the Methodology

The literature identifies various methods to capture the intersectoral interdependence or the economic impacts of a specific sector on the broader economy. Cost-benefit analysis assesses a project's feasibility through expected costs and benefits, but lacks information on the economic impact diffusion within the system. Econometric modelling, like structural macroeconomic modelling and regression analysis, captures relationships between output, GDP, and other macroeconomic variables, but only addresses direct impacts, neglecting indirect effects through sectoral interdependence. Internal indices

of purchase and sale along with matrix triangulation also capture sectoral interdependence but without extensive data collection and computational demands (Pagoulatos *et al*, 1986).

Computable general equilibrium (CGE) analysis and input-output (I-O) analysis are widely used to fully capture the sectoral interdependence. CGE forecasts the effects of future changes in economic variables, offering more functionality than I-O analysis (Weisbrod & Weisbrod, 1997); however, it requires sophisticated simulation modelling, which is costly and time-consuming. Input-output analysis, on the other hand, involves minimal programming and effectively measures the impact of changes in final demand on various sectors and the entire economy. It uses market transaction tables linked to the national accounting system, which are frequently updated (Dimitriou *et al*, 2015). I-O models offer high transparency regarding assumptions and processing mechanisms and they more easily handle sector disaggregation in complex economic systems (Logar & Van Den Bergh, 2013).

Input-Output Analysis of the Natural Gas Sector in India

This section outlines the procedures used in applying the I-O methodology to estimate and analyse the economic multiplier effects of the natural gas sector in India.

Data Source

India's journey in compiling I-O tables spans three distinct periods (Kuwamori & Sato, 2009). Initially, in the early 1950s, individual researchers undertook the compilation. From the late 1950s to the early 1970s, the Indian Statistical Institute (ISI) led the efforts. By the late 1970s, the Government of India officially began compiling and publishing I-O tables.

In 1978, the Central Statistical Organisation (CSO), in collaboration with the Planning Commission, produced the first official I-O table for India, covering 60 sectors for the years 1968-69 (NAS, 1978). Subsequent editions expanded the sectoral detail, including tables that cover 115 sectors from 1973-74 and 130 sectors from 2003-04.In January 2015, the CSO introduced a new series of national account statistics, replacing the traditional I-O table with the Supply and Use Table (SUT) for the Indian economy. The SUT provides a more detailed and integrated framework for understanding the production and consumption processes, interdependencies, and income generation within the economy. This shift aimed to reconcile statistical discrepancies in previous national accounting methodologies. It offers an accurate balance of supply and demand and establishes a coherent linkage of output with intermediate and final uses of products (CSO, 2015).

The present study compiled an I-O table in value terms for 2018-19 based on the SUT for the same year. The table was constructed following the guidelines of the compilation of the I-O table from SUT provided by the United Nations System of National Accounting (UN-SNA) (Beutel *et al*, 2018; Eurostat, 2008). It applied the industry-technology assumption(Miller & Blair, 2009), which posits that each industry has its own unique production process, regardless of the product mix. This assumption implies that each industry has a distinct input structure (Beutel *et al*, 2018).The SUT for 2018-19 includes 140 products and 66 sectors organized in a rectangular supply-and-use system. This structure allows for the application of the product-technology assumption(Beutel *et al*, 2018; Eurostat, 2008).

Consequently, the resultant I-O table has a 140×140 structure, where 140 products are supplied to 140 sectors, enabling products and industries to be used interchangeably.

Input-Output Model for the Natural Gas Sector

As a theoretical framework and applied economic tool, the I-O analysis was first introduced and developed in 1936 by Wassily Leontief (Leontief, 1951). The I-O analysis quantifies the impacts of changes in economic variables on interconnected sectors. It captures interactions across different economic sectors, including final demand, at local and regional levels. It also provides feedback effects on income and employment. The assumptions underlying the I-O analysis are as follows: Each industry produces only one product without secondary production, resulting in a square and symmetric inter-industry transaction table. Industries adhere to a fixed-coefficient linear production function, requiring a specific amount of input per unit of output with no input substitution or economies of scale. Sectors use inputs from other sectors in fixed proportions, constant irrespective of changes in output levels. Additionally, inter-industry input flows for a given period depend solely on that period's output, with no inter temporal substitution.

The I-O model demonstrates the observed inter-industrial flow of input and output, measured either in physical or monetary terms. When the natural gas sector (j) produces output for a particular period, it demands input from the sector i (itself and other sectors) for the same period, and this inter-sectoral flow of input is denoted as z_{ij}. In the rest of the section, the terms, sector and industry, will be used interchangeably. In addition to the intermediate good flow, it also consists of the final consumption of goods and services considered exogenous to the model.

Assume an economy with *n* industries, each producing $x_i(\mathrm{i} = 1,2,\cdots,n)$ total output to be used by the same *n* industries as inputz_{ij} $(i = 1,2,\cdots,n; j = 1,2,\cdots,n)$ for further production and to be used as the final demand f_i for the sector i's output. The simple linear equation to demonstrate the output flow of sector i to other industries j and final demand f_i can be written as.

$$x_i = z_{i1} + \cdots + z_{ij} + \cdots + z_{in} + f_i \tag{1}$$

The above notation can be summarized in the following general linear equation.

$$x = Zi + f \tag{2}$$

Here,$i = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$ of *n* dimension and known as summation vector and post-multiplication of this vector with matrix Z gives column vector, whose elements are row sum of the matrix Z. Each sector j uses some inputs from itself, which are termed as intra-industry inputs. However, the sectors also use primary inputs such as labour, capital, and inventory. The sum of these primary inputs is termed as value-added to these n sectors. The payment sectors consist of mainly three components, i.e., first, labour services l_i denotes employee compensation, second, other value-added items n_i denotes combined taxes paid to the government, interest payment to capital, rental payments, profit, and so on, and last, import payments m_i denotes payments made towards the imports of inputs. Similarly, the final demand sector also consists of private final consumption expenditure (PFCE), government final

consumption expenditure (GFCE), investment demand or change in stock (CIS), and exports of the final product.

Table1: Structure of the Input-Output Table

			Producers as Consumers				**Final Demand**				**Total Output**
			I1	I2	…	In	PFCE	GFCE	CIS	Exports	
Producers		I1									**x1**
		I2									**x2**
		⍰									
		In									**Xn**
Payments	**Value-Added**	Employees	Employee Compensation (Labour Services)								**L**
		Capital, Profit, Government Taxes	Taxes paid to government, interest payments to capital, rental payments, entrepreneurial profit								**N**
		Imports	Imports of inputs from abroad								**M**
Total outlays			**x1**	**x2**		**xn**					**GDP**

Source: Author's Compilation

Production Function and the Input-Output Model

The intermediate flow of the input to an industry j (natural gas sector) from industry i depends entirely on the output of the industry $j$in a given period. Hence, we can write the functional relationship between the intermediate flow of inputs from sector i to sector j and the output of sector j(Miller & Blair, 2009) as

$$z_{ij} = f(x_j) \tag{3}$$

Hence, at the given intermediate flow (z_{ij}) and output of sector $j(x_j)$, the input coefficient which describes for each unit production of sector j how much output of sector i is being absorbed as input. This can be written as

$$a_{ij} = \frac{z_{ij}}{x_j} \tag{4}$$

The notation a_{ij} is also the technical coefficient or input-output coefficient of the natural gas sector (j). Since the producing sector j also uses primary inputs along with intermediate goods from its own and other $n-1$ sectors, the column sum of the technical coefficient should be less than 1.

$$\sum_{i=1}^{n} a_{ij} < 1 \; (i = 1, 2, \ldots\ldots, n) \tag{5}$$

Here, the technical coefficient is assumed to be proportionally fixed across sectors, representing constant returns to scale. Using the definition of technical coefficient and ignoring the contribution of the payments sector for a moment, we can also write the total output of the natural gas sector $j(x_j)$ as

$$x_j = \frac{z_{1j}}{a_{1j}} = \frac{z_{2j}}{a_{2j}} = \cdots = \frac{z_{nj}}{a_{nj}} \tag{6}$$

However, if sector j does not use input from any particular sector, the technical coefficient for that sector will be zero and the ratio of inter industry flow to technical coefficient will be infinitely large. Hence, the production function used in the I-O model follows the specification listed below (Rasmussen *et al*, 1967).

$$x_j = \min\left(\frac{z_{1j}}{a_{1j}}, \frac{z_{2j}}{a_{2j}}, \cdots, \frac{z_{nj}}{a_{nj}}\right) \tag{7}$$

We can rewrite the equation by replacing

$$z_{ij} = a_{ij}\, x_j \tag{8}$$

which gives technical coefficient matrix A as

$$A = Z\hat{x}^{-1} \tag{9}$$

Hence, the system of the equation can be written in linear form as

$$x = Ax + f \tag{10}$$

The n general equilibrium relationships between the total output of all n producing sectors and the final demands of output produced by these sectors can be described as

$$(I - A)x = f \tag{11}$$

Let I be an identity matrix with value 1 in its principal diagonal and 0 elsewhere

$$I = \begin{bmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 1 & \cdots & 1 \end{bmatrix} \text{ hence } (I - A) = \begin{bmatrix} (1 - a_{11}) & -a_{12} & \cdots & -a_{1n} \\ -a_{21} & (1 - a_{22}) & \cdots & -a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & -a_{n2} & \cdots & (1 - a_{nn}) \end{bmatrix} \tag{12}$$

The Leontief matrix or total requirement matrix L

$$L = \begin{bmatrix} L_{11} & \cdots & L_{1n} \\ \vdots & \ddots & \vdots \\ L_{n1} & \cdots & L_{nn} \end{bmatrix} \tag{13}$$

can be obtained through inversion of the matrix $(I - A)$ and gives a unique solution to the system equation of unknown x in terms of known y. If the matrix $I - A$ is non-singular, a unique solution to the system equation can be obtained from the following equation

$$x = (I - A)^{-1} f = Lf \tag{14}$$

The coefficient L_{ij} of the matrix,L, indicates the required increase in output of sector i if the final demand of sector j (natural gas sector) increases by one unit. In case of an increase in final demand for sector j, sector i will be affected directly as well as indirectly as it is providing inputs to itself as well as other sectors. Similarly, other sectors are affected both directly and indirectly. Hence, from the computational point of view, the coefficient L_{ij} depends on the technical coefficients (a_{ij}) of the n sectors. the matrix L is used to estimate the multipliers of the sectors.

Estimating Linkages of the Natural Gas Sector

Backward Linkages

The backward linkage (BL) can be defined as the interlinkages of a sector with other sectors, where the former purchases inputs from the latter sector. The BL effect of the natural gas sector presents the power of dispersion, which is the average of all products' elements in the total requirement matrix' natural gas column divided by the average of all sectors' elements (Guitton & Rasmussen, 1957).
The total backward linkage of natural gas is the column sum of the total requirement matrix(Miller & Blair, 2009).

$$BL_j^T = \sum_{i=1}^{n} l_{ij} \tag{15}$$

However, to compare the backward linkage scores of the different sectors, Guitton & Rasmussen(1957) suggested normalized backward linkage (NBL) scores.

$$NBL_j^T = \frac{BL_j}{\frac{1}{n}\sum_{k=1}^{n} BL_k} \tag{16}$$

Forward Linkages

The forward linkages (FL) of a sector can be defined as the interlinkages of a sector with other sectors, where the former supplies inputs to the latter sectors. The natural gas sector's FL effect presents the power of dispersion, which is the average of all sector elements in the natural gas sector row of the Ghosh inverse matrix divided by the average of all sector elements(Guerra & Sancho, 2011). Ghosh representation of the I-O framework considers the model's supply side rather than the demand side or Leontief model discussed so far. Ghosh's alternative explanation for the coefficient relates primary inputs to the total output, called the output coefficient matrix, rather than the input coefficient matrix in the Leontief demand-side model. This can be obtained by dividing each row of the intermediate flow matrix by respective row sum or total output. Ghosh inverse matrix (G)can be obtained following a similar step as the Leontief inverse matrix (L).

The total forward linkage of the natural gas sector is the row sum of the Ghosh inverse matrix.

$$FL_i^T = \sum_{i=1}^{n} g_{ij} \tag{17}$$

The normalized forward linkages (NFL) score can be obtained to compare the sectoral score of the forward linkages.

$$NFL_i^T = \frac{FL_j}{\frac{1}{n}\sum_{k=1}^{n} FL_k} \tag{18}$$

Estimation of Multipliers for the Natural Gas Sector

The term 'multiplier' represents an excess of the effects over a certain initial effect caused by the exogenous changes in the short run. In other words, the multiplier is the difference between the total and initial effects of an exogenous change. The multiplier's magnitude depends on the extensiveness of the total effects. When total effects capture direct and indirect effects (open input-output mode – the household sector is exogenous), the multipliers are called simple multipliers. When total effects capture direct, indirect, and induced effects (closed input-output model – the household sector is endogenous), the multipliers are called total multipliers.

Output Multiplier

The total required value of production in the rest of the sectors of the economy to satisfy a rupee worth final demand for the natural gas sector's (j) output is defined as an output multiplier for the natural gas sector (j). When a rupee worth final demand for the natural gas sector's output increases, it requires the output of the sector itself as well as that of the other sectors as input. The one-rupee worth of output of the natural gas sector to satisfy the one-rupee increase in the final demand of the natural gas sector is termed the initial output effect. The ratio of the sum of direct and indirect effects to the initial output effect of the natural gas sector is known as the simple output multiplier. In other words, it is the column sum of the total requirement matrix of the natural gas sector (j).

The simple output multiplier for the natural gas sector (j) can be written as (Miller & Blair, 2009)

$$m(o)_j = \sum_{i=1}^{n} l_{ij} \tag{19}$$

Similarly, the total output multiplier can be calculated using the same procedure by making the household sector endogenous to the model. After endogenizing the household sector into the model, it will have total $n+1$ sectors. Hence, the multiplier will also include the induced effect of the change in final demand for the natural gas sector's output.

Income Multipliers

The income multiplier for the natural gas sector (j) can be defined as the monetary income generated by a rupee increase in final demand for the natural gas sector's output. Let $h' = [z_{n+1,j}\,(j = 1 \dots n)]$ be the household row vector of the wage earned by a household in each sector in the monetary term, then the household input coefficient can be calculated as

$$h_c' = h'\hat{x}^{-1} = [a_{n+1,j}\ (j = 1 \dots n)] \tag{20}$$

Therefore, the simple income multiplier for the natural gas sector (j) can be calculated as

$$m(h)_j = \sum_{i=1}^{n} a_{n+1,i}\, l_{ij} \tag{21}$$

Similarly, the total income multiplier for the natural gas sector can be calculated using the same procedure, which makes the household sector endogenous to the model.

The household input coefficient $[a_{n+1,j}]$ represents the initial income effect in terms of additional income payments to the household if the final demand for the natural gas sector (j) output increases by one rupee.

Next, by dividing the simple income multiplier of the natural gas sector by its initial income effect or household input coefficient, we can get the type I income multiplier for that sector (Emonts-Holley *et al*, 2021; Miller & Blair, 2009; Moore, 1955). Similarly, a type II income multiplier can be calculated using the same procedure by endogenizing the household sector into the model.

Physical Employment Multipliers

The number of jobs generated due to one rupee increase in the final demand for the natural gas sector's output is known as physical employment multiplier. The calculation of physical employment multipliers follows the same procedures as income multipliers by defining thee' row vector in physical labour unit terms rather than monetary terms.

$$e_c' = e'\hat{x}^{-1} = [a_{n+1,j}\ (j = 1 \dots n)] \tag{22}$$

Therefore, the simple employment multiplier for the natural gas sector (j) can be calculated as

$$m(e)_j = \sum_{i=1}^{n} a_{n+1,i}\, l_{ij} \tag{23}$$

Value-Added Multipliers

The value-added multiplier for the natural gas sector shows much value-added is created in each sector due to a rupee-worth increase in final demand for the natural gas sector's output. The calculation of value-added multipliers is the same as the calculation of income multipliers. However, at the place of h' row vector, we provide value-added for each sector as $v' = [v_{n+1,j}\ (j = 1 \dots n)$. The sectoral value-added coefficient can be calculated using the same procedure as the technical coefficients.

$$v_c' = v\hat{x}^{-1} \tag{24}$$

It is often argued that since value-added captures the value of total output over the cost of total intermediate inputs used by the sector, the value-added multiplier measures the sector's contribution better than that measured through output multipliers(Miller & Blair, 2009).

Results and Discussion

Linkages of Natural gas with Other Economic Sectors

The Indian economic sectors have strong BL and FL effects, as the score was greater than 1 for both (Appendix 1). Overall, the BL for the Indian economy was 1.72, while the FL was 1.88. Natural resources, including energy resources sectors, provide input to the production process in various other economic sectors, and hence, in general, are supposed to have stronger FL than BL. The natural gas sector, a vital component of the Indian economy, engenders intricate economic interconnections

through FL and BL. However, the sector serves as the key economic sector with stronger FL (NFL: 1.57) than BL (NBL: 0.789). Forward linkages encompass the dissemination of natural gas-derived products and services into other sectors, influencing approximately 40 sectors. It has a profound impact on mining and quarrying activities, textile and electrical manufacturing, petrochemicals, other chemical sectors, and the construction industry. Conversely, BL denote the dependencies of the natural gas sector on products and services from 34 sectors, prominently rooted in the service domain, including transportation, finance, and other business services. This intricate network of BL highlights the sector's reliance on ancillary services to sustain operations and foster growth.

Backward Linkages of the Natural Gas Sector

Appendix 1 summarizes the sectoral score of BL and NBL.The natural gas sector's BL score of 1.357 indicates a moderate influence on other sectors, generating ₹0.357 worth of demand for every rupee of output. However, its NBL score of 0.789 suggests that the BL is relatively weak. This is largely due to India's high import dependency on natural gas, limited reserves, and fewer operational fields. Despite this, as an energy resource, the sector's strong FL underline its importance to the economy.However, as an energy resource sector, the natural gas sector is supposed to have stronger FL than BL. Hence, a lower BL score does not imply that the sector is not important to the Indian economy.

Compared to other energy sectors, the natural gas sector's BL score is lower than that of crude petroleum (NBL score: 0.803) and coal and lignite (NBL score: 0.891). The dominance of crude petroleum and coal, with their extensive operational areas and historical precedence, contributes to this discrepancy. However, the energy landscape in India is shifting towards a balanced and sustainable mix, with natural gas gaining prominence due to government initiatives, environmental concerns, and infrastructure advancements.

Table 1 presents the ranking of sectors that have significant BL with the sector. Crude petroleum has the largest BL with the natural gas sector (0.046), followed by services like machinery renting (0.039) and business services (0.039). The strong linkage with crude petroleum stems from the operational needs of the natural gas sector, such as machinery, processing, and transportation, often utilizing associated gas from oil fields. The natural gas sector, being capital intensive, also requires significant machinery, equipment, and ancillary services. Overall, the natural gas sector is primarily backwardly linked with other energy resource sectors and various services, including machinery renting, business services, transportation, and construction. This network of linkages underscores the sector's reliance on diverse inputs to sustain its operations and growth.

Table 2: Backward Linkages in the Natural Gas Sector

Sectors	Backward Linkages of Natural Gas	Ranking
Crude petroleum	0.045584	1
Renting of machinery & equipment	0.038972	2
Other business services	0.038647	3
Miscellaneous manufacturing	0.029719	4
Land transport	0.023025	5
Financial services	0.020577	6
Construction and construction services	0.019373	7
Petroleum products	0.012079	8
Trade	0.011431	9
Electricity	0.00949	10

Source: Author's computation

Forward Linkages of the Natural Gas Sector

Appendix 1 also summarizes the sectoral FL score and NBL score. FL highlight supply-oriented economic linkages, typically stronger for sectors with broader consumer bases. The FL score for natural gas is 2.957, indicating that for every ₹1 of production, ₹1.957 is directly or indirectly linked to other economic sectors. The NFL score is 1.570, reflecting the sector's significant role in the economy. A high FL for the gas sector (0.449) shows natural gas's substantial contribution to liquified petroleum gas (LPG) production and transmission. It also has strong linkages with petroleum products (0.233), providing essential feedstock for petroleum oils, gas oils, lubricating oils, and other petroleum products. Moreover, natural gas is crucial for organic chemical production (0.094), fertilizers (0.041), and various chemicals like paints, varnishes, lacquers (0.060), soaps, cosmetics, and glycerine (0.034). It also plays a role in wholesale and retail trade (0.094), is used for heating and cooling in construction (0.087) and serves as an input for land transportation (0.086).

Table 3: Forward Linkages in the Natural Gas Sector

Sectors	Forward Linkages of Natural Gas	Ranking
Gas	0.448943	1
Petroleum products	0.233279	2
Trade	0.094348	3
Organic chemicals	0.0941	4
Construction and construction services	0.086678	5
Land transport	0.085531	6
Paints, varnishes, and lacquers	0.060085	7
Miscellaneous manufacturing	0.049915	8
Fertilizers	0.040788	9
Soaps, cosmetics, and glycerine	0.034156	10

Source: Author's computation

Impacts of Natural Gas on Sectoral Macroeconomic Variables

In addition to the inter-sectoral linkages analysis, the I-O model also analyses the impact of changes in final demand for natural gas on sectoral output, household income, and employment. Multiplier analysis, which assesses the direct, indirect, and induced effects of exogenous changes, is employed to do this. When household final demand is exogenous, simple multiplier analysis captures direct and indirect impacts. Direct impacts come through the industry, while indirect impacts refer to those coming through other industries in the economy. When households are endogenous, the total multiplier analysis includes induced changes. The induced changes come through the participation of the household sector in the I-O flow, where the household sector supplies labour inputs to other sectors and consumes the products of other industries. The household sector also employs labour for household purposes, further contributing to the total multiplier. Hence, it becomes important to report the induced effect of exogenous change in the natural gas sector to capture the impacts of the natural gas sector on the economy.

Sector Output (production inducing effect)

Appendix 2 provides details of the impact of natural gas investment due to a unit change in the final demand for the sector. A unit change in demand for natural gas increases economy-wide output with a production-induced effect of 1.357. This means a ₹1 investment in natural gas yields an additional ₹1.357 in output, with ₹1 as the initial effect and ₹0.357 as direct and indirect demand across natural gas (₹0.005) and various other sectors. Crude petroleum, machinery rental, professional services, miscellaneous manufacturing, land transport, financial services, and construction are the most affected by investments in the natural gas sector. However, this multiplier does not account for the induced effects, which consider changes in household income and expenditure due to increased demand. The induced effect arises from additional household income through labour payments and consumer spending on goods produced by the natural gas sector and other sectors. The total output multiplier, which includes these induced effects, is 2.728. This indicates that direct, indirect, and induced demands occur due to a unit change in final demand for the sector. In a closed input-output model, where households are endogenous, a ₹1 investment in the natural gas sector necessitates ₹0.356 in labour services and ₹0.086 in land transportation, with trade, housing, and financial services also significantly impacted.

Income and Employment of the Household

An exogenous change in the I-O model can affect household income and employment. This is done by converting the Leontief inverse matrix into income or employment using the wage or labour input coefficient. Results indicate that an additional rupee of final demand for natural gas directly and indirectly generates ₹0.201 in additional household income (Appendix 2). This income includes ₹0.144 directly from the natural gas sector, followed by professional, technical, and other business services (₹0.0099), renting services (₹0.0094), crude petroleum (₹0.0058), and other sectors. When households are considered endogenous in the model, the same additional demand for natural gas yields ₹0.356 in household income. The impact on employment indicates that an increase in the final demand for natural

gas by ₹1crore creates 293 jobs across the economy. This includes 45 jobs in business services, 41 in the natural gas sector, 37 in land transportation, 28 in construction, and 22 in renting services. When households are endogenous, an additional ₹1 crore output in the natural gas sector generates 1958 jobs across various sectors through direct, indirect, and induced effects.

Additionally, the effect of an exogenous change in natural gas production on income and employment includes the initial income generated in that sector. The income and employment multipliers indicate economy-wide household income per unit of final demand for natural gas, excluding the initial income impact. The Type I multiplier shows ₹1.406 in household income or 7 jobs for every additional ₹1 production in the natural gas sector. The induced effect of the household sector leads to an increase of₹2.487 or 47 jobs, respectively. The income and employment multipliers consider the household as endogenous, with the initial effect of new production termed Type II multipliers. Appendix 2 summarizes these results for the natural gas sector.

Value-added Multiplier

Value added rather than total output often provides a better situation for the sector while analysing the contribution of an economic sector engaged in the production of goods and services. The value added is the difference between the value of total output and the total cost of intermediary inputs of a sector. The results indicate that for each additional unit change in the final demand of the natural gas sector, the value added of the natural gas sector increases by ₹0.55 directly while₹0.719 is the economy-wide contribution of the sector (Appendix 2). The multiplier value includes the direct and indirect impact of the exogenous change in final demand. Like the output multiplier, business services, renting services, crude petroleum, and financial services were highly ranked in terms of impacts on the value added by the sector. Considering households as an endogenous sector and incorporating the resultant induced effect, the total value-added multiplier of the natural gas sector stood at 1.259. This indicates that an additional unit change in final demand for the sector generates an additional value-added of ₹1.259 considering direct, indirect, and induced effects. In the total value-added multiplier, dwelling services, trade, financial services, land transport, and other business services ranked higher in terms of impacts on the value added. Appendix 2 summarizes the value of the value-added multiplier for the natural gas sector.

Conclusion

The study highlights the economic implications of the natural gas sector in the economy. The results analyse the impact of the current allocation or supply of natural gas to different sectors through its push and pull capacity at economy and sectoral levels. It also analyses the impacts on the macroeconomic variables of the sector such as sectoral output, income, employment, and value added. The natural gas sector has strong FL (1.57) and moderate BL (0.789). BL analysis showed that the sector generates ₹0.357 in demand from other sectors for every additional rupee of output, mainly due to high import dependency and limited domestic reserves. Compared to crude petroleum and coal, natural gas has lower BL scores, emphasizing its emerging role in India's energy landscape. FL reveal that for every ₹1 of production, ₹1.957 is connected to other sectors, highlighting the sector's significant contribution to

various production processes. Multiplier analysis indicated a production-induced effect of 1.357, demonstrating the sector's positive impact on overall economic output, household income, and employment.

The analysis gives insights into the economic justification of India's natural gas allocation based on its impact on the different sectors and overall economy. The analysis reveals that a few sectors, such as gas supply, petroleum products, and construction, receive significant FL from the natural gas sector. Additionally, the manufacturing of chemicals, cosmetics, and other miscellaneous items receives a significant push from the natural gas sector. Hence, the allocation policy should focus on supplying more natural gas to these sectors as it will enhance the economic impact of the natural gas sector on Indian economy. These sectors also pass the changes in natural gas prices to consumers more smoothly than the other prioritized sectors in the economy (Sen, 2015). However, the reason for prioritizing supply to some of the sectors, such as fertilizer and other strategically important sectors, is based on socio-political narratives, which is out of the scope of this study.

In conclusion, the natural gas sector is crucial to India's economy, with strong FL and moderate BL. As India moves towards a sustainable energy mix, natural gas is becoming increasingly important, influencing multiple sectors and driving economic growth. Understanding these linkages is essential for effective policy-making and strategic planning.

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Appendices

Appendix 1: Backward Linkage and Forward Linkages Cores of all Sectors

	Backward Linkages		**Forward Linkages**	
Industries/Products/Sectors	**BL score**	**NBL Score**	**FL score**	**NFL Score**
Paddy	1.278	0.743	1.690	0.897
Wheat	1.278	0.743	1.735	0.922
Coarse cereals	1.278	0.743	1.526	0.811
Gram	1.277	0.743	1.742	0.925
Arhar	1.278	0.743	1.574	0.836
Other pulses	1.278	0.743	1.829	0.971
Groundnut	1.277	0.743	1.369	0.727
Rapeseed and mustard	1.278	0.743	2.249	1.194
Other oil seeds	1.278	0.743	2.220	1.179
Kapas	1.278	0.743	2.633	1.398
Jute, hemp and mesta	1.277	0.743	2.554	1.356
Sugarcane	1.278	0.743	1.945	1.033
Coconut	1.277	0.743	1.248	0.663
Tobacco	1.278	0.743	1.369	0.727
Tea	1.277	0.743	2.316	1.230
Coffee	1.278	0.743	1.974	1.048
Rubber	1.278	0.743	3.088	1.640
Fruits	1.278	0.743	1.153	0.612
Vegetables	1.278	0.743	1.304	0.693
Other food crops	1.278	0.743	1.810	0.961
Milk	1.311	0.763	1.404	0.746
Wool	1.311	0.762	2.422	1.286
Egg and poultry	1.311	0.763	1.334	0.708
Other livestock products	1.311	0.763	1.307	0.694
Industry wood	1.249	0.727	2.781	1.477
Firewood	1.249	0.727	1.043	0.554
Other forestry products	1.249	0.727	2.148	1.141
Inland fish	1.233	0.717	1.300	0.691
Marine fish	1.233	0.717	1.201	0.638

Coal and lignite	1.532	0.891	3.493	1.855
Natural gas	1.357	0.789	2.957	1.570
Crude petroleum	1.381	0.803	3.122	1.658
Iron ore	1.937	1.127	3.418	1.815
Manganese ore	1.796	1.044	3.496	1.856
Bauxite	1.796	1.044	3.238	1.720
Copper ore	1.796	1.044	3.143	1.669
Other metallic minerals	1.796	1.044	3.082	1.637
Limestone	1.513	0.880	3.417	1.814
Mica	1.981	1.152	2.959	1.571
Other non-metallic minerals	1.626	0.946	2.885	1.532
Processed poultry meat products	2.375	1.381	1.145	0.608
Processed other meat products	2.375	1.381	1.238	0.658
Processed fish & fish products	2.375	1.381	1.325	0.704
Processed fruits &vegetables	2.354	1.369	1.340	0.712
Dairy products	2.248	1.307	1.138	0.604
Edible oils and fats	2.375	1.381	1.736	0.922
Grain mill and starch products	2.303	1.339	1.462	0.776
Sugar	2.191	1.275	1.318	0.700
Bread &bakery products	2.191	1.275	1.073	0.570
Miscellaneous food products	2.206	1.283	1.197	0.636
Alcoholic beverages	2.078	1.209	1.181	0.627
Non-alcoholic beverages	2.080	1.210	1.085	0.576
Tea processed	2.191	1.275	1.450	0.770
Coffee processed	2.192	1.275	1.619	0.860
Tobacco products	1.902	1.106	1.067	0.567
Cotton Yarn and Textiles	2.184	1.270	1.601	0.850
Synthetic yarn and textiles	2.169	1.262	1.867	0.992
Wool yarn and textiles	2.184	1.270	1.970	1.046
Silk yarn and textiles	2.184	1.270	1.805	0.959
Carpet weaving	2.184	1.270	1.246	0.662
Readymade garments	2.172	1.263	1.213	0.644
Misc. textile products	2.180	1.268	1.542	0.819
Leather footwear	2.045	1.189	1.096	0.582
Leather and leather products	2.045	1.189	1.498	0.795
Wood and wood products	1.861	1.082	2.720	1.445
Paper, Paper products	2.078	1.208	2.455	1.304
Publishing, printing and allied	1.977	1.150	1.868	0.992
Furniture & Fixtures	2.037	1.185	1.819	0.966
Rubber products	2.053	1.194	2.217	1.177
Plastic products	2.053	1.194	2.165	1.150
Petroleum products	1.413	0.822	2.136	1.134
Coal tar products	1.413	0.822	2.718	1.443
Inorganic chemicals	2.032	1.182	2.960	1.572

Organic chemicals	1.898	1.104	2.625	1.394
Fertilizers	2.040	1.187	2.803	1.489
Pesticides	2.040	1.187	2.352	1.249
Paints, varnishes and lacquers	2.040	1.187	1.954	1.037
Drugs and medicine	1.820	1.059	1.529	0.812
Soaps, cosmetics and glycerine	2.029	1.180	1.318	0.700
Synthetic fibres, resin	2.081	1.210	2.661	1.413
Other chemical products	1.906	1.109	2.926	1.554
Cement	1.981	1.152	2.479	1.317
Non-metallic mineral products	1.981	1.152	2.379	1.263
Iron and steel Ferro alloys	2.398	1.395	3.545	1.882
Iron and steel casting and forging	2.397	1.394	2.540	1.349
Iron and steel foundries	2.398	1.395	2.410	1.280
Non-ferrous basic metals	2.216	1.289	2.668	1.417
Hand tools, hardware	2.226	1.294	2.157	1.146
Miscellaneous metal products	2.224	1.293	2.193	1.164
Tractors and agricultural implements	2.121	1.233	1.193	0.633
Industrial machinery for food and textile	2.120	1.233	1.149	0.610
Industrial machinery others	2.121	1.234	1.065	0.566
Machine tools	2.136	1.242	2.053	1.090
Other non-electrical machinery	2.141	1.245	1.386	0.736
Electrical industrial machinery	2.145	1.247	1.219	0.648
Electrical cables, wires	2.178	1.267	2.043	1.085
Batteries	2.174	1.265	1.829	0.971
Electrical appliances	2.177	1.266	1.548	0.822
Communication equipment	2.205	1.282	1.390	0.738
Other electrical machinery	2.143	1.246	1.608	0.854
Electronic equipment, T.V	2.335	1.358	1.375	0.730
Medical precision, optical instrument	2.007	1.167	1.378	0.732
Watches and clocks	1.925	1.119	1.372	0.728
Ships and boats	2.232	1.298	1.104	0.586
Rail equipment	2.232	1.298	1.337	0.710
Motor vehicles	2.232	1.298	1.608	0.854
Motor cycles and scooters	2.232	1.298	1.362	0.723
Bicycles, cycle-rickshaw	2.232	1.298	1.768	0.939
Aircraft& Spacecraft	2.232	1.298	1.269	0.674
Other transport equipment	2.232	1.298	2.393	1.271
Gems & jewellery	2.189	1.273	1.106	0.587
Miscellaneous manufacturing	2.111	1.228	2.314	1.229
Construction and construction services	2.021	1.175	1.376	0.731
Electricity	1.754	1.020	2.478	1.316
Gas	2.185	1.271	1.577	0.837
Water Supply	1.693	0.985	1.995	1.059
Trade	1.505	0.875	1.936	1.028

Repair & Maintenance of Motor Vehicle	1.357	0.789	2.353	1.250
Hotels & Restaurant	1.950	1.134	1.376	0.731
Railway Transport	1.532	0.891	1.785	0.948
Land transport	1.860	1.082	1.615	0.857
Air transport	2.231	1.298	1.891	1.004
Water Transport	1.768	1.028	1.060	0.563
Auxiliary transport activities	1.872	1.089	2.813	1.494
Storage and warehousing	1.884	1.096	2.755	1.463
Communication services	1.879	1.093	1.920	1.020
Financial services	1.442	0.839	2.106	1.118
Insurance services	1.578	0.918	1.571	0.834
Ownership of dwellings	1.059	0.616	1.000	0.531
Real estate services	1.668	0.970	1.702	0.904
Renting of machinery & equipment	1.636	0.952	1.763	0.936
Research & Development Services	1.348	0.784	1.737	0.923
Legal services	1.353	0.787	1.957	1.039
Other Business services	1.613	0.938	2.109	1.120
Computer related services	1.461	0.850	1.178	0.625
Public administration and defence	1.354	0.788	1.000	0.531
Education services	1.348	0.784	1.158	0.615
Human health and social care services	1.607	0.935	1.182	0.628
Community, social and personal services	1.454	0.846	1.337	0.710
Recreation, entertainment, broadcasting	1.657	0.964	1.749	0.929

Source: Author's computation

Appendix 2: Values of Output, Income, Employment, and Value-Added Multipliers of the Natural Gas Sector

Industries/Products/Sectors	**Output Multiplier**		**Income Multiplier**		**Employment Multiplier**		**Value Added Multiplier**	
	Simple	**Total**	**Simple**	**Total**	**Simple**	**Total**	**Simple**	**Total**
Paddy	0.0005	0.0146	0.00006	0.01121	0.09296	2.63963	0.00041	0.01166
Wheat	0.0003	0.0097	0.00003	0.00748	0.04879	1.54376	0.00025	0.00778
Coarse cereals	0.0001	0.0043	0.00001	0.00328	0.01533	0.67802	0.00008	0.00342
Gram	0.0002	0.0029	0.00002	0.00222	0.03381	0.45853	0.00017	0.00231
Arhar	0.0000	0.0009	0.00000	0.00073	0.00377	0.15034	0.00002	0.00076
Other pulses	0.0001	0.0023	0.00001	0.00179	0.01266	0.36986	0.00006	0.00186
Groundnut	0.0000	0.0018	0.00000	0.00135	0.00215	0.27936	0.00001	0.00141
Rapeseed and mustard	0.0001	0.0017	0.00001	0.00129	0.00896	0.26654	0.00005	0.00134
Other oil seeds	0.0001	0.0026	0.00001	0.00200	0.01567	0.41331	0.00008	0.00208
Kapas	0.0003	0.0031	0.00004	0.00241	0.05346	0.49527	0.00027	0.00251
Jute, hemp and mesta	0.0000	0.0003	0.00000	0.00025	0.00566	0.05211	0.00003	0.00026
Sugarcane	0.0001	0.0065	0.00002	0.00498	0.00575	0.26385	0.00011	0.00518
Coconut	0.0000	0.0014	0.00000	0.00109	0.00005	0.00986	0.00001	0.00113
Tobacco	0.0000	0.0005	0.00000	0.00038	0.00004	0.01529	0.00000	0.00040
Tea	0.0000	0.0007	0.00000	0.00056	0.00172	0.05413	0.00002	0.00059

Coffee	0.0000	0.0003	0.00000	0.00025	0.00079	0.02363	0.00001	0.00026
Rubber	0.0001	0.0002	0.00001	0.00017	0.00034	0.00133	0.00005	0.00018
Fruits	0.0001	0.0167	0.00001	0.01286	0.00111	0.32587	0.00005	0.01337
Vegetables	0.0001	0.0157	0.00002	0.01208	0.00583	0.64017	0.00011	0.01256
Other food crops	0.0003	0.0195	0.00004	0.01503	0.00493	0.27599	0.00028	0.01563
Milk	0.0006	0.0425	0.00008	0.03922	0.00825	0.61467	0.00044	0.03260
Wool	0.0000	0.0000	0.00000	0.00002	0.00001	0.00008	0.00000	0.00001
Egg and poultry	0.0000	0.0073	0.00000	0.00670	0.00015	0.03913	0.00002	0.00557
Other livestock products	0.0001	0.0112	0.00002	0.01033	0.00199	0.16194	0.00011	0.00859
Industry Wood	0.0016	0.0057	0.00020	0.00496	0.00376	0.01304	0.00137	0.00475
Firewood	0.0000	0.0039	0.00000	0.00339	0.00004	0.00890	0.00001	0.00324
Other forestry products	0.0001	0.0020	0.00001	0.00173	0.00020	0.00454	0.00007	0.00165
Inland Fish	0.0000	0.0078	0.00001	0.00696	0.00022	0.03721	0.00004	0.00667
Marine Fish	0.0000	0.0064	0.00000	0.00572	0.00004	0.00805	0.00002	0.00547
Coal and Lignite	0.0029	0.0060	0.00045	0.00658	0.00803	0.01679	0.00169	0.00353
Natural Gas	1.0046	1.0069	0.14380	1.00691	0.41648	0.41743	0.55059	0.55185
Crude petroleum	0.0456	0.0507	0.00583	0.04531	0.01706	0.01897	0.02255	0.02508
Iron ore	0.0007	0.0017	0.00008	0.00130	0.00084	0.00204	0.00029	0.00069
Manganese ore	0.0001	0.0001	0.00001	0.00013	0.00014	0.00037	0.00003	0.00007
Bauxite	0.0000	0.0001	0.00001	0.00010	0.00010	0.00028	0.00002	0.00005
Copper ore	0.0000	0.0001	0.00000	0.00005	0.00005	0.00013	0.00001	0.00003
Other Metallic minerals	0.0003	0.0009	0.00004	0.00084	0.00080	0.00237	0.00015	0.00045
Limestone	0.0002	0.0005	0.00003	0.00068	0.00103	0.00289	0.00013	0.00036
Mica	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Other non-metallic minerals	0.0014	0.0048	0.00021	0.00499	0.00765	0.02595	0.00083	0.00282
Processed poultry meat products	0.0000	0.0002	0.00000	0.00003	0.00001	0.00275	0.00000	0.00002
Processed other meat products	0.0000	0.0005	0.00000	0.00009	0.00010	0.00710	0.00000	0.00005
Processed fish & fish products	0.0000	0.0007	0.00000	0.00011	0.00012	0.00311	0.00000	0.00006
Processed fruits Vegetables	0.0000	0.0021	0.00000	0.00036	0.00010	0.00935	0.00000	0.00023
Dairy products	0.0000	0.0099	0.00000	0.00291	0.00006	0.02199	0.00000	0.00109
Edible Oils and Fats	0.0003	0.0124	0.00001	0.00194	0.00020	0.00962	0.00002	0.00114
Grain Mill and starch products	0.0004	0.0246	0.00001	0.00448	0.00125	0.07050	0.00006	0.00339
Sugar	0.0001	0.0132	0.00001	0.00818	0.00014	0.01610	0.00003	0.00312
Bread & Bakery products	0.0000	0.0036	0.00000	0.00225	0.00003	0.03611	0.00000	0.00086
Miscellaneous food products	0.0000	0.0090	0.00000	0.00507	0.00041	0.08786	0.00001	0.00201
Alcoholic beverages	0.0000	0.0031	0.00000	0.00150	0.00006	0.00801	0.00001	0.00114
Non-alcoholic beverages	0.0000	0.0016	0.00000	0.00078	0.00004	0.01344	0.00000	0.00059
Tea processed	0.0000	0.0021	0.00000	0.00132	0.00008	0.01059	0.00000	0.00050
Coffee processed	0.0000	0.0004	0.00000	0.00023	0.00002	0.00187	0.00000	0.00009
Tobacco Products	0.0000	0.0045	0.00000	0.00124	0.00008	0.16184	0.00000	0.00181
Cotton Yarn and Textiles	0.0007	0.0173	0.00004	0.00661	0.01148	0.30288	0.00018	0.00477
Synthetic yarn and textiles	0.0002	0.0013	0.00001	0.00050	0.00273	0.02297	0.00004	0.00036
Wool yarn and textiles	0.0000	0.0008	0.00000	0.00030	0.00080	0.01353	0.00001	0.00021
Silk yarn and textiles	0.0000	0.0008	0.00000	0.00031	0.00064	0.01426	0.00001	0.00022

Carpet weaving	0.0000	0.0007	0.00000	0.00025	0.00074	0.01155	0.00001	0.00018
Readymade garments	0.0003	0.0101	0.00004	0.00894	0.00659	0.20813	0.00010	0.00328
Misc. textile products	0.0006	0.0078	0.00004	0.00335	0.01038	0.13936	0.00016	0.00219
Leather footwear	0.0000	0.0029	0.00000	0.00462	0.00006	0.02794	0.00000	0.00100
Leather and leather products	0.0000	0.0012	0.00001	0.00183	0.00032	0.01381	0.00001	0.00040
Wood and wood products	0.0007	0.0038	0.00007	0.00258	0.01672	0.09195	0.00024	0.00133
Paper, Paper products	0.0015	0.0070	0.00009	0.00302	0.00595	0.02799	0.00039	0.00183
Publishing, printing and allied	0.0004	0.0033	0.00003	0.00207	0.00833	0.07419	0.00014	0.00124
Furniture & Fixtures	0.0005	0.0032	0.00008	0.00326	0.00871	0.05123	0.00018	0.00106
Rubber products	0.0008	0.0037	0.00005	0.00185	0.00258	0.01267	0.00018	0.00088
Plastic products	0.0011	0.0060	0.00008	0.00303	0.00379	0.02010	0.00027	0.00145
Petroleum products	0.0121	0.0422	0.00025	0.00599	0.00239	0.00837	0.00146	0.00512
Coal tar products	0.0005	0.0024	0.00001	0.00035	0.00010	0.00048	0.00006	0.00030
Inorganic chemicals	0.0009	0.0029	0.00004	0.00091	0.00078	0.00256	0.00022	0.00072
Organic chemicals	0.0022	0.0081	0.00009	0.00223	0.00176	0.00636	0.00050	0.00179
Fertilizers	0.0004	0.0051	0.00002	0.00161	0.00036	0.00458	0.00010	0.00129
Pesticides	0.0002	0.0017	0.00001	0.00054	0.00021	0.00186	0.00005	0.00043
Paints, varnishes and lacquers	0.0006	0.0062	0.00002	0.00193	0.00050	0.00559	0.00014	0.00154
Drugs and medicine	0.0005	0.0130	0.00004	0.00758	0.00128	0.03284	0.00023	0.00596
Soaps, cosmetics and glycerine	0.0001	0.0046	0.00001	0.00151	0.00050	0.02019	0.00003	0.00120
Synthetic fibres, resin	0.0003	0.0029	0.00002	0.00095	0.00024	0.00201	0.00009	0.00074
Other chemical products	0.0023	0.0050	0.00009	0.00137	0.00718	0.01529	0.00052	0.00110
Cement	0.0015	0.0044	0.00008	0.00160	0.00330	0.00972	0.00050	0.00149
Non=metallic mineral products	0.0008	0.0025	0.00004	0.00089	0.01619	0.05029	0.00027	0.00083
Iron and steel Ferro alloys	0.0033	0.0082	0.00008	0.00141	0.01188	0.02906	0.00057	0.00140
Iron and steel casting and forging	0.0025	0.0069	0.00006	0.00121	0.00139	0.00385	0.00043	0.00119
Iron and steel foundries	0.0025	0.0071	0.00006	0.00123	0.00136	0.00392	0.00042	0.00121
Non-ferrous basic metals	0.0012	0.0034	0.00003	0.00061	0.00172	0.00489	0.00018	0.00052
Hand tools, hardware	0.0008	0.0037	0.00007	0.00246	0.00285	0.01353	0.00023	0.00108
Miscellaneous metal products	0.0011	0.0032	0.00008	0.00180	0.01385	0.04251	0.00027	0.00084
Tractors and agricultural implements	0.0001	0.0003	0.00001	0.00018	0.00026	0.00112	0.00002	0.00008
Industrial machinery for food and textile	0.0000	0.0001	0.00000	0.00004	0.00030	0.00080	0.00001	0.00002
Industrial machinery others	0.0001	0.0002	0.00001	0.00011	0.00068	0.00097	0.00004	0.00005
Machine tools	0.0011	0.0030	0.00010	0.00198	0.00557	0.01524	0.00035	0.00095
Other non-electrical machinery	0.0001	0.0005	0.00001	0.00034	0.00052	0.00190	0.00005	0.00016
Electrical industrial machinery	0.0001	0.0004	0.00001	0.00025	0.00065	0.00206	0.00004	0.00012
Electrical cables, wires	0.0003	0.0010	0.00002	0.00056	0.00096	0.00370	0.00006	0.00025
Batteries	0.0001	0.0004	0.00001	0.00021	0.00037	0.00158	0.00002	0.00009
Electrical appliances	0.0003	0.0009	0.00002	0.00046	0.00096	0.00299	0.00007	0.00020
Communication equipment	0.0000	0.0002	0.00000	0.00005	0.00029	0.00119	0.00001	0.00003
Other electrical machinery	0.0004	0.0012	0.00003	0.00063	0.00079	0.00264	0.00009	0.00030
Electronic equipment, T.V	0.0002	0.0015	0.00001	0.00055	0.00033	0.00307	0.00002	0.00020
Medical precision, optical instrument	0.0001	0.0002	0.00001	0.00014	0.00024	0.00081	0.00002	0.00006
Watches and clocks	0.0000	0.0001	0.00000	0.00011	0.00009	0.00060	0.00001	0.00005

Ships and boats	0.0000	0.0000	0.00000	0.00000	0.00002	0.00011	0.00000	0.00000
Rail equipment	0.0000	0.0001	0.00000	0.00003	0.00058	0.00150	0.00001	0.00002
Motor vehicles	0.0017	0.0132	0.00010	0.00552	0.00243	0.01881	0.00046	0.00354
Motor cycles and scooters	0.0005	0.0035	0.00003	0.00148	0.00083	0.00642	0.00012	0.00095
Bicycles, cycle-rickshaw	0.0001	0.0007	0.00001	0.00027	0.00027	0.00176	0.00003	0.00018
Aircraft& Spacecraft	0.0000	0.0000	0.00000	0.00001	0.00003	0.00021	0.00000	0.00001
Other transport equipment	0.0004	0.0012	0.00002	0.00050	0.00038	0.00127	0.00009	0.00032
Gems & jewellery	0.0001	0.0039	0.00001	0.00131	0.00131	0.04238	0.00002	0.00058
Miscellaneous manufacturing	0.0297	0.0481	0.00188	0.02126	0.04007	0.06485	0.00750	0.01215
Construction and construction services	0.0194	0.0504	0.00446	0.08092	0.28613	0.74377	0.00700	0.01819
Electricity	0.0095	0.0351	0.00123	0.03186	0.01403	0.05192	0.00384	0.01419
Gas	0.0014	0.0075	0.00017	0.00656	0.00165	0.00905	0.00033	0.00181
Water Supply	0.0019	0.0067	0.00029	0.00720	0.00600	0.02157	0.00107	0.00384
Trade	0.0114	0.0846	0.00129	0.06662	0.18433	1.36407	0.00753	0.05575
Repair & Maintenance of Motor Vehicle	0.0024	0.0088	0.00029	0.00752	0.02735	0.10215	0.00178	0.00664
Hotels & Restaurant	0.0024	0.0222	0.00013	0.00860	0.03870	0.36399	0.00081	0.00759
Railway Transport	0.0085	0.0183	0.00199	0.02998	0.03090	0.06662	0.00546	0.01177
Land transport	0.0230	0.0860	0.00367	0.09569	0.37169	1.38790	0.01006	0.03757
Air transport	0.0016	0.0041	0.00007	0.00128	0.00214	0.00552	0.00020	0.00050
Water Transport	0.0000	0.0001	0.00000	0.00014	0.00017	0.00101	0.00001	0.00006
Auxiliary transport activities	0.0086	0.0174	0.00131	0.01860	0.02910	0.05932	0.00358	0.00730
Storage and warehousing	0.0002	0.0014	0.00004	0.00178	0.00315	0.02102	0.00010	0.00070
Communication services	0.0083	0.0394	0.00116	0.03823	0.02809	0.13286	0.00317	0.01501
Financial services	0.0206	0.0646	0.00484	0.10616	0.08735	0.27439	0.01505	0.04727
Insurance services	0.0043	0.0133	0.00086	0.01852	0.01525	0.04725	0.00266	0.00825
Ownership of dwellings	0.0000	0.0667	0.00000	0.19141	0.00000	0.03089	0.00000	0.06452
Real estate services	0.0015	0.0124	0.00032	0.01816	0.00316	0.02564	0.00082	0.00668
Renting of machinery & equipment	0.0390	0.0402	0.00937	0.06759	0.22102	0.22814	0.02297	0.02370
Research & Development Services	0.0035	0.0051	0.00120	0.01246	0.00418	0.00620	0.00266	0.00394
Legal services	0.0015	0.0081	0.00046	0.01710	0.01093	0.05779	0.00119	0.00629
Other Business services	0.0386	0.0551	0.00987	0.09832	0.45559	0.64967	0.02324	0.03314
Computer related services	0.0016	0.0054	0.00045	0.01041	0.00371	0.01235	0.00115	0.00383
Public administration and defence	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Education services	0.0010	0.0304	0.00036	0.07383	0.01986	0.58336	0.00079	0.02334
Human health and social care services	0.0004	0.0193	0.00013	0.03985	0.00577	0.25618	0.00027	0.01210
Community, social and personal services	0.0015	0.0210	0.00044	0.04373	0.03902	0.55632	0.00103	0.01467
Recreation, entertainment, broadcasting	0.0070	0.0120	0.00188	0.02238	0.05233	0.08895	0.00410	0.00696
Household		0.3561				0.18091		
Total	1.3568	2.7275	0.20131	0.356056	2.93051	19.58709	0.71867	1.25937
Total (Type I)			1.406394		7.068854			
Total (Type II)				2.487432		47.24722		

Source: Author's computation

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