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Economic Contributions of the Oil and Gas Industry in Assam: An Assessment of the Direct and Indirect Impacts

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Abstract

The oil and gas industry has had a commanding presence in the economy of Assam for well over a century. However, the colonial origin of the industry and its enclave and extractive nature often raise questions regarding its contribution to the local economy. Given this context, a systematic assessment of the role of the industry in the state's economy was felt pertinent. The present study carries out such an assessment by capturing both the direct impact on income and employment generation and the indirect impacts using multipliers from input-output tables. The results show that, in 2018–19, the industry directly contributed 9.02% of Assam's Gross State Domestic Product (GSDP) but employed 57,800 persons, merely 4.59% of the state's organised sector workforce. Its indirect income contribution, equivalent to 13.88% of GSDP, exceeded the direct contribution, so that the total (direct and indirect) income generated amounted to ₹74,116.84 crore (approximately ₹741 billion). The industry also contributed ₹4,086.24 crore (approximately ₹40.9 billion), or 29.08% of the state's total revenue, through payments of taxes, royalties and other levies.

Keywords: Gross Value Added (GVA); Employment Generation; State Exchequer; Royalty Payments; Assam; India

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Introduction

The oil and gas industry in Assam has a long history dating back to the late 19th Century. European engineers laying railway tracks accidentally found traces of oil in the jungles of Upper Assam in 1867. By 1889, India's first commercially viable oil well was struck in Digboi, Assam. The Digboi Refinery, commissioned in 1901, is Asia's first and the world's oldest operating oil refinery (Saikia, 2011). Post-independence, the discovery of major oil fields in Naharkatiya and Moran in the 1950s further solidified Assam's position in India's oil economy. However, until the mid-20th Century, the industry was largely controlled by foreign entities like the Burmah Oil Company. In 1956, with the establishment of the Oil and Natural Gas Commission (ONGC) and the subsequent formation of Oil India Limited (OIL) in 1959, control over the industry shifted to domestic players. This transition coincided with India's broader strategy of nationalising critical industries and expanding state control over natural resources. Overall, while Assam's oil and gas industry has evolved significantly from its colonial roots, its strategic importance to both Assam and India's energy security continues to underscore its relevance. The oil and gas industry in Assam consists of four major segments: exploration and production, transportation, refining, and marketing and distribution.

Despite the significant presence of the industry in the state, the enclaved nature of the industry during the colonial period did not allow much linkage with the rest of the economy, leaving the prosperity from it mostly unshared with the local population. Further, the extractive nature of the industry also meant that colonial industrialisation resulted in the gradual denudation of the natural resource base of the state. After independence, nationalisation of both mining and refining brought the petroleum industry from the clutches of colonial capital to the state capital.

Exploration, refining, and distribution activities of the industry now generate both direct and indirect employment (Chakraborty, 2005). Additionally, the industry has had substantial fiscal contributions, including taxes, royalties, and other levies, bolstering the state's revenues (Sarma, 2004). However, the industry also presents challenges, such as environmental risks, infrastructural constraints, and limited integration with other sectors of the state's economy (Bhatia, 1974; Gogoi, 2012).

Given its colonial origin, ownership and operational changes after independence and the impending challenges and opportunities because of the emerging local and global concerns, it is felt that a detailed study of the contribution of the oil and gas sector to the economy of Assam and its future potential contributions is necessary. The financial year 2018–19 has been adopted as the reference period for the empirical analysis. This year was chosen for three reasons. First, it was the most recent year for which complete data (Value Added Statements, employment records, and royalty and tax payments) could be obtained from all the operating companies. Second, it was the last normal year before the COVID-19 pandemic: the end of 2019–20 was affected by the nationwide lockdown, and 2020–21 by the collapse in demand and crude oil prices and by the Baghjan gas well blowout of May 2020, which disrupted OIL's operations in Upper Assam. Third, by 2018–19 the transitional effects of the introduction of the Goods and Services Tax (GST) in July 2017 had largely worked through, so the fiscal data reflect a settled tax regime. Data relating to gross value added, employment, production and fiscal contributions correspond to this period. Indirect income and employment effects are estimated using the 2013–14 All-India Input-Output Table, since no updated national or state-level Input-Output table with comparable sectoral detail is currently available for the study period. Accordingly, this study was undertaken with the following specific objectives.

- To estimate the direct impact of the oil and gas industry on the economy of Assam in terms of income and

employment generation, and contribution to the state exchequer.
- To estimate the indirect income and employment generation by the industry within the state of Assam

The Oil and Gas Industry of Assam: Present Status

The oil and gas industry in Assam comprises four segments: exploration and production, transportation, refining, and marketing and distribution.

- **Exploration and Production**: Assam is a significant onshore producer of crude oil in India, contributing around 12.18% of the country's crude oil output. The key players in the exploration and production activities include Oil India Limited (OIL) and the Oil and Natural Gas Corporation Limited (ONGC). The oil fields are primarily located in the Upper Assam Shelf and the Assam-Arakan Fold Belt basins. These areas have vast proven reserves of approximately 1.6 billion tonnes. The extraction process involves locating and drilling oil reserves, making this phase highly capital-intensive and technologically demanding.
- **Refining:** Assam is home to four major refineries: Digboi, Guwahati, Bongaigaon, and Numaligarh. These refineries have a combined processing capacity of 7 million metric tonnes per annum (MMTPA), contributing significantly to refining India's crude oil. The Digboi refinery, the world's oldest operational refinery, is particularly noteworthy for producing premium-grade waxes. Modernisation efforts in these refineries have ensured that they meet domestic energy demands while maintaining environmental standards (Aguilera et al., 2009). The Numaligarh Refinery, for instance, has invested in advanced technologies such as hydrocracking and delayed coking to optimise its output and improve its environmental sustainability.
- **Transportation**: The transportation of crude oil and natural gas is managed through an extensive network of pipelines across the state. Assam's pipeline network ensures the steady flow of crude oil to refineries and connects production sites to consumer markets. Key entities such as OIL, ONGC, and Gas Authority of India Limited (GAIL) manage the transportation infrastructure. These pipelines also serve as a critical link between Assam and other regions, facilitating both domestic distribution and inter-state transfers of oil and gas.
- **Marketing and Distribution**: The distribution of refined petroleum products is managed by public sector oil marketing companies (OMCs), such as Indian Oil Corporation Limited (IOCL), Hindustan Petroleum Corporation Limited (HPCL) and Bharat Petroleum Corporation Limited (BPCL), alongside private players. The region's extensive retail network includes over 890 outlets, while liquefied petroleum gas (LPG) distribution is handled by eight bottling plants across the state. Additionally, the integration of refined products into local and national supply chains strengthens Assam's role in India's broader energy network.

Overall, while Assam's oil and gas industry has evolved significantly from its colonial roots, its strategic importance to both Assam and India's energy security underscores its continuing relevance.

Data and Methodology

Data Source

Information was compiled from publicly available reports and databases, including the annual reports of Oil India Limited (OIL), Oil and Natural Gas Corporation Limited (ONGC), Indian Oil Corporation Limited (IOCL) and Numaligarh Refinery Limited (NRL); Indian Petroleum & Natural Gas Statistics, published by the Ministry of Petroleum and Natural Gas (MoPNG), Government of India; data of the Directorate of Economics and Statistics (DES), Government of

Assam; and the National Accounts Statistics (NAS) of the National Statistics Office (NSO), Ministry of Statistics and Programme Implementation (MoSPI), Government of India. These were combined with specific data collected from different units of the major oil and gas companies, including the Guwahati Refinery (GR), Bongaigaon Refinery (BGR) and Digboi Refinery (Assam Oil Division, AOD) of IOCL, and with data generated through surveys and semi-structured interviews with key stakeholders, including oil operators, refinery managers and service providers. These surveys captured information on employment generation, value addition and operational details across the upstream, midstream and downstream segments of the industry. In all, 12 semi-structured interviews were conducted: five with officials of the exploration and production companies (OIL and ONGC), four with managers of the four refineries, and three with contractors and service providers. Company officials were approached through formal letters of request issued by the Department of Economics, Gauhati University, to the human resources and corporate communications departments of the respective units, which nominated the officials to be interviewed. Contractors and service providers were identified from the lists of contracted firms supplied by OIL and ONGC and were contacted directly. The interviews were conducted with respondents in their official capacity and sought only institutional information on employment, operations and value added; no personal information was collected. Participation was voluntary, and oral informed consent was obtained after the purpose of the study and the intended use of the information had been explained. To maintain confidentiality, the names and designations of the respondents are not disclosed, and the information they provided is reported only in aggregated form at the level of the company or segment. All monetary values are expressed in Indian rupees (₹) at current prices and, following the convention of Indian official statistics, are reported in crore, where one crore equals ten million rupees.

Methodology

To estimate the direct economic contribution of the industry, the study uses the Gross Value Added (GVA) approach. This method calculates the value added by the oil and gas industry by subtracting the cost of intermediate consumption (that is, raw materials, energy, and operational expenses) from the total output (that is, sales and stock changes) of the industry. To estimate the indirect economic impacts, the study applies an Input-Output (I-O) Model (Tang et al., 2013) utilising the 2013–14 Input-Output Table for India compiled by the National Council of Applied Economic Research (NCAER) (Singh & Saluja, 2018). This model helps quantify the inter-industry linkages, capturing how the output from the oil and gas industry supports other sectors of the economy. The I-O table was adjusted to match the sectoral structure of the oil and gas industry, enabling the calculation of output, income, and employment multipliers. These multipliers include the ripple effects of industry activities across the broader economy, besides its direct contributions to the economy.

Since a state-specific Input-Output (I-O) table for Assam is not available for the reference year 2018–19, this study employs the 2013–14 All-India Input-Output Table compiled by NCAER as the most appropriate proxy for estimating indirect income and employment effects. The use of national I-O tables as proxies for regional economies is a widely accepted practice in regional economic impact analysis when regional social accounting matrices or state-level I-O tables are unavailable (Miller & Blair, 2009). The underlying assumption is that the production technology and inter-industry relationships of the petroleum sector are broadly similar across regions because the industry's production processes are highly standardised and operate under common national regulatory and technological frameworks. Nevertheless, the use of a national I-O table introduces certain limitations. Regional economies generally differ from the national economy in terms of industrial composition, import dependence, inter-state trade, and intermediate input sourcing. Consequently, the

multipliers derived from the national table may not fully capture leakages arising from imports of intermediate goods and services from other states or region-specific supply-chain characteristics. Therefore, the estimated indirect income and employment effects should be interpreted as reasonable approximations rather than precise state-level estimates. Despite this limitation, the national I-O framework provides the most comprehensive and consistent basis currently available for assessing the broader economic impacts of Assam's oil and gas industry (Das et al., 2023).

It should be emphasised that the use of national coefficients is more likely to overstate than to understate the indirect effects for Assam. National technical coefficients describe input requirements that can be met from anywhere within India, whereas in a small, landlocked and resource-dependent regional economy such as Assam, a large share of the intermediate inputs purchased by the petroleum industry (drilling rigs and other heavy machinery, steel tubulars, catalysts and speciality chemicals, and specialised engineering and technical services) is sourced from other states or imported from abroad. These purchases constitute leakages from the regional economy. Applying national coefficients implicitly treats them as local purchases, so that successive rounds of inter-industry spending are attributed to Assam even though a substantial part of this spending takes place outside the state (Miller & Blair, 2009). Similarly, a considerable part of the profits of the centrally owned public sector undertakings, and of the incomes of senior personnel who are not permanent residents of Assam, is spent or retained outside the state, which weakens the induced consumption effects within Assam. The literature on non-survey regionalisation of input-output tables shows that regional multipliers are systematically smaller than national multipliers and that the difference increases as the size of the region decreases relative to the nation (Flegg et al., 1995; Miller & Blair, 2009). Furthermore, the five-year gap between the reference year of the I-O table (2013–14) and the study period (2018–19) means that subsequent changes in relative prices, technology and input sourcing are not reflected in the coefficients. For these reasons, the indirect income and employment estimates reported in Section 6 should be interpreted as upper-bound approximations of the effects retained within Assam. More precise estimates would require regionalising the national table, for example through location-quotient-based adjustments (Flegg et al., 1995), or compiling a survey-based input-output table for Assam, which remains an important area for future research.

While data on direct employment in the industry were gathered from reports of operating units, employment multipliers borrowed from the Input-Output tables were used to assess the total employment impact, including both direct and indirect job creation.

Direct Contributions to State Income

Direct income contribution of the industry to the economy of Assam has been worked out by calculating the value added by it in the reference year. This metric represents the gross income created by the sector, derived from key factors of production such as land, labour, capital, and organisational inputs (Bhattacharya & Datta, 2004).

The study employs both the additive method and the subtractive method to estimate the value added. In the additive model, value added is calculated as the total contribution distributed to employees, the government, capital providers, and shareholders. Conversely, the subtractive model computes value added as the difference between the industry's total sales and the cost of goods and services procured from external entities (Haller & Van, 2014). The choice of method was dictated by the format in which data were available for each sub-sector of the industry. The additive method was applied to the refining segment (the Guwahati, Bongaigaon and Digboi refineries of IOCL, and NRL) and to OIL, for which unit-level Value Added Statements were available; for these units, value added was obtained as the sum of compensation of employees, payments to the government (taxes, duties and royalties), interest paid to providers of capital, dividends to shareholders, and retained earnings including depreciation.

The subtractive method was applied to the Assam operations of ONGC (Assam Asset, Jorhat Basin and Silchar Basin), for which separate Value Added Statements were not published but data on the value of output and the cost of goods and services purchased from external entities were obtainable; for these operations, value added was computed as the value of output less the cost of such bought-in inputs. It is to be noted that the entire profit of the industry does not accrue to residents of Assam. Since the objective is to estimate the contribution of the industry to the economy of Assam, the share of profit accruing to non-residents was deducted. This deduction was made on the basis of the ownership structure of each company: the profit component of value added (dividends and retained earnings) was apportioned in proportion to equity shareholding, and only the share attributable to Assam, principally the Government of Assam's equity stake in NRL (12.35% in 2018–19), was retained, whereas the shares attributable to the Government of India, the parent public sector companies and other shareholders were treated as accruing to the rest of the country and excluded. Compensation of employees, royalties and state taxes paid within Assam were retained in full.

The contribution of the industry to the income generation process in the state of Assam is summarised in Table 1. Between 2014-15 and 2018-19, the industry's GVA ranged from 8.94% to 9.51% of the state's GSDP. However, a notable trend observed is a gradual decline in the industry's share of the state's industrial GVA, which decreased from 44.56% in 2014-15 to 34.79% in 2018-19. This reduction indicates that while the industry remains a key contributor to the state's economy, its relative importance in the broader industrial sector has been diminishing.

Table 1: GVA at Market Price of the Oil and Gas Industry of Assam and its Shares in Industrial and Overall State Gross Domestic Product

Year	GVA at Current Prices (₹ crore for Crude Oil & Gas only)	% of Industrial GSDP	% of GSDP
2014-15	13,405.90	44.56	8.94
2015-16	12,822.03	41.92	9.42
2016-17	12,536.55	42.69	9.10
2017-18	14,021.40	40.80	9.51
2018-19	18,464.29	34.79	9.02

Source: Authors' calculation based on data from (a) Directorate of Economics and Statistics, Assam and National Statistics Office, Ministry of Statistics & Programme Implementation (MoSPI), Govt. of India (b) Value Added Statement of Guwahati Refinery (GR), Bongaigaon Refinery (BGR), Digboi Refinery (AOD), Numaligarh Refinery (NRL), Oil India Limited and Oil and Natural Gas Corporation Limited (ONGC)

The estimated contribution of approximately 9% of Assam's GSDP confirms that the petroleum industry continues to function as one of the principal drivers of the state's economy despite the gradual diversification of the industrial sector. This finding is broadly consistent with earlier studies which recognised petroleum as one of the dominant sources of industrial value addition and public revenue in Assam (Bhattacharya & Datta, 2004; Gogoi, 2012; Das et al., 2023). However, unlike previous studies that mainly examined the financial performance of individual public sector enterprises or sectoral productivity, the present study estimates the industry's aggregate contribution by integrating upstream, midstream and downstream activities. The declining share of industrial GVA despite rising absolute value added suggests that other industrial activities in Assam have expanded at a relatively faster pace during recent years. Therefore, the findings indicate that although the oil and gas industry remains

economically indispensable, Assam's industrial structure is gradually becoming more diversified.

Direct Contribution to Employment Generation in the State

Direct employment refers to the number of full-time jobs generated directly within an industry, encompassing roles that are integral to its core operations. According to Boyce and Nøstbakken (2011), direct employment involves jobs that are inherently part of the industry's functions, such as workers operating oil drilling rigs or those employed in natural gas processing plants and crude oil refineries. All full-time employment by oil operators, pipeline companies, processors, and marketing firms is categorised as direct employment. Often, oil operators subcontract specialised firms to manage exploration and extraction activities, and the workforce employed by these firms is also counted as direct employment.

Employment in the Exploration and Production Segment

Employment data for this segment were collected from the DES, Assam, and surveys conducted among oil operators, refineries, and service firms. Key industry players such as OIL, ONGC and other local refineries and service firms contributed to these figures. The survey specifically sought data on full-time and part-time employment within the sector, covering a wide range of operational roles.

Oil operators in Assam typically subcontract exploration and extraction activities to specialised firms that handle distinct aspects of these processes. For instance, OIL and ONGC provided lists of companies contracted for exploration, extraction, and transportation services in Assam. Among the notable contractors are Simplex Infrastructure Limited, Quippo Oil and Gas Infrastructure Limited, and JayBee Energy Pvt. Limited. These contractors manage various tasks, including the charter hiring of rigs, water disposal well drilling, and vendor services for the drilling rig package. In 2018-19, OIL employed 1,484 executives, 109 additional staff, and 4,793 unionised workers across its operations. Additionally, the company engaged 4,745 contract workers at its field headquarters in Duliajan. Employment on man-management rigs, which include the hiring of crews for specific drilling projects, amounted to 600 personnel. However, data for charter-hired rig employment was not available.

ONGC also reported significant employment figures in 2018-19, with 1,483 executives in Nazira, 619 in Jorhat Basin, and 175 in Silchar Basin. Non-executive employment included 1,929 workers in Nazira and additional personnel across other basins. The total estimated employment for contract work in the Jorhat Basin was 870, with 391 contract workers employed at the basin's headquarters. Although employment data for Assam Asset and Silchar Basin were not fully available, estimates based on ratios of executive and contract work indicated that around 3,475 workers were engaged in these areas.

Overall, the exploration and production segment in Assam employed 3,809 executives, 7,620 non-executives, and approximately 10,081 contract workers during the 2018-19 period. This diverse employment landscape underscores the oil and gas industry's vital role in job creation within the state, particularly in the E&P sector.

Employment in the Transportation Segment

Employment in this segment is primarily focused on the operations of pipelines, tankers, and other transportation methods necessary for transferring petroleum products.

Crude oil is typically stored in large-diameter holding tanks before being transported through pipelines, trucks, railroads, or tankers to refineries for processing. The employment generated within this segment is closely tied to the infrastructure required to manage these transportation processes. Natural gas, depending on its physical state, is transported via pipeline (for methane) or tanker trucks (for natural gas liquids). Additionally, storage solutions such as depleted reservoirs, aquifers, or salt caverns are used to preserve underground natural gas

The employment generated by companies involved in the transportation of natural gas,

such as GAIL, Duliajan Numaligarh Pipeline Limited (DNPL), and Assam Gas Company Limited (AGCL) in Assam, remains difficult to quantify because comprehensive workforce data are not publicly available. Available information indicates that crude oil extracted from ONGC-operated assets in the Jorhat and Silchar Basins is transported through a combination of pipelines and contracted tanker services. In the Jorhat Basin, 20 tankers employed approximately 60 workers, while employment in the Assam Asset and Silchar Basin was estimated using the observed ratio of regular to contractual personnel.

For the transportation of refined petroleum products, IOCL employed 65 executives and 60 non-executive personnel in transportation-related operations. In addition, a substantial workforce is engaged through outsourced logistics and tanker operators. For example, NRL operates around 200 tankers, generating employment for approximately 600 contractual workers, together with personnel engaged in two Multi-Discharge Vehicles (MDVs). Similarly, the Bongaigaon Refinery operates 112 tankers and about 1,000 LPG bullets, generating employment for approximately 3,345 contractual workers. These 3,345 workers represent only the transportation workforce associated with the Bongaigaon Refinery and are one component of the contractual employment reported for the transportation segment. The remaining contractual workforce comprises personnel engaged by other refinery transportation systems (including Guwahati and Digboi Refineries), crude-oil transportation contractors serving OIL and ONGC operations, pipeline operators, and other outsourced logistics service providers. Consequently, the total contractual employment in the transportation segment is estimated at 8,470 workers, as reported in Table 2.

The dominance of contractual workers over regular executive and non-executive staff in this segment reflects the way petroleum logistics are organised in Assam. Pipeline transportation is highly capital-intensive and largely automated, with flows monitored and controlled through centralised supervisory control and data acquisition (SCADA) systems; it therefore requires only a small core of permanent executive and technical personnel for planning, supervision, safety and maintenance. By contrast, the movement of crude oil from fields that are not connected to trunk pipelines, and of refined products and LPG from refineries and terminals to depots, dealers and bottling plants, is undertaken by road tankers, rail tankers and LPG bullets that are owned and operated by private transport contractors under term contracts. The oil companies treat these activities as non-core and outsource them in order to reduce fixed labour costs and to adjust capacity to fluctuations in throughput. The drivers, helpers, loaders and maintenance workers engaged in these operations are employed by the contractors rather than by the oil companies and are therefore recorded as contractual workers. Consequently, regular executive and non-executive employees account for less than 2% of employment in the transportation segment, whereas contractual workers account for more than 98%.

Overall, employment in the transportation segment of the oil and gas industry in Assam during 2018–19 comprised 65 executives, 60 non-executive employees, and approximately 8,470 contractual workers, resulting in a total employment of 8,595 persons. These estimates reflect the labour-intensive nature of petroleum logistics and include both directly employed personnel and workers engaged through contractual transport and logistics service providers.

Employment in the Refinery Segment

Employment within refineries is generally categorised into executive/managerial, non-executive, and contractual positions. Additionally, refineries rely on part-time labour for tasks related to plant maintenance, facility upgrades, and specific project implementations, contributing further to the employment ecosystem.

Employment generation in this segment extends beyond core operational activities. Refineries also engage workers through contractual

arrangements, both on a regular basis and for part-time roles during high-demand periods, such as plant shutdowns or breakdowns. The transition from part-time to full-time employment is a common practice in the sector, where short-term engagements can often be consolidated into permanent positions. For instance, multiple part-time roles may combine to equal one full-time job over a sustained period of employment.

As shown in Table 2, in 2018–19, IOCL reported a workforce of 369 executives and 562 non-executives across its refineries in Guwahati, Bongaigaon, and Digboi. NRL, another major player, employed 460 executives and 420 non-executives during the same period. The contractual workforce in refineries was substantial, with approximately 6,000 employees hired through regular contracts, along with 300 full-time equivalent roles. These employment figures reflect the importance of refineries as direct and indirect job creators in the state.

Overall, the refinery segment contributed an estimated 1,472 executive jobs and 2,035 non-executive positions in 2018-19, in addition to around 6,300 contractual positions. The comprehensive employment structure within the refinery sector underscores its vital role in supporting both the local economy and the broader labour market in Assam. The diversity of job types, including managerial, technical, and operational roles, highlights the segment's capacity to generate varied employment opportunities across skill levels.

Employment in the Marketing Segment

This segment generates significant employment opportunities through both wholesale and retail activities, particularly in the management of petrol stations and distribution centres. Employment in this segment is broadly categorised into executive, non-executive, and contractual positions, reflecting the diverse operational needs associated with the marketing of petroleum products. In 2018–19, IOCL employed 372 executives and 341 non-executives in its marketing division in Assam. This division oversees the operation of retail outlets, storage terminals, and distribution points across the state. IOCL, along with HPCL and BPCL, manages a network of 580, 125, and 186 retail outlets, respectively, in Assam. Additionally, the three companies collectively oversee 550 LPG distributors and 359 superior kerosene oil/light diesel oil (SKO/LDO) dealerships. This extensive distribution network supports various forms of employment, ranging from managerial positions to service roles in logistics, transportation, and retail sales.

Moreover, the marketing segment operates crucial infrastructure, including 7 petroleum, oil and lubricants (POL) terminal depots, 12 aviation fuelling stations, and 8 LPG bottling plants. These facilities further contribute to employment by necessitating the management and transportation of petroleum products. Based on operational data, total employment in the marketing segment, including contractual roles, was estimated at 16,915 jobs in 2018-19.

Total Direct Employment in the Industry in Assam

The oil and gas industry in Assam serves as a significant source of employment across multiple sectors, including exploration and production, transportation, refining, and marketing. In 2018-19, the total number of persons directly employed in the oil and gas sector in Assam amounted to 57,800, distributed across executive, non-executive, and contractual roles in various segments. These figures were compiled based on reports from key industry operators and government departments.

The largest share of direct employment is concentrated in the exploration and production segment, which employs 3,809 executives, 7,620 non-executives, and 10,081 contractual workers. This segment accounts for the majority of employment within the oil and gas industry, highlighting the labour-intensive nature of upstream operations. In the transportation sector, the number of individuals employed is more limited, with 65 executives, 60 non-executives, and 8,470 contractual workers. Transportation includes the movement of crude oil and natural gas via pipelines, tankers, and other means, contributing significantly to

contractual employment due to the logistical demands of the industry. The refining segment is another major contributor to employment, with 1,472 executives, 2,035 non-executives, and 6,300 contractual workers. Refining operations in Assam are spread across several facilities, including the Guwahati, Bongaigaon, and Digboi refineries, which require a diverse range of labour to manage day-to-day operations and maintenance activities.

As shown in Table 2, the marketing segment, which handles the distribution and sale of petroleum products, directly employs 372 executives, 341 non-executives, and 16,915 contractual workers. Marketing activities include the management of retail outlets, LPG distribution, and fuel transportation, generating a significant number of jobs, particularly under contractual terms.

Table 2: Number of Persons Employed Directly in the Oil and Gas Sector of Assam in 2018-2019

Sector/Subsector	Executive	Non-Executive	Contractual	Others	Total
Exploration & Production	**3,809**	**7,620**	**10,081**	**90**	**21,600**
Transportation	**65**	**60**	**8,470**	**N/A**	**8,595**
Refining	**1,472**	**2,035**	**6,300**	**170**	**9,977**
Marketing	**372**	**341**	**16,915**	**N/A**	**17,628**
Overall	**5,718**	**10,056**	**41,766**	**260**	**57,800**

Source: Authors' calculation based on the data on employment from the annual report of Indian Petroleum & Natural Gas Statistics, OIL, ONGC, BGR, AOD, NRL.
Note: The contractual employment reported for the transportation segment (8,470 workers) is an aggregate estimate covering transportation activities associated with OIL, ONGC, IOCL, NRL, Bongaigaon Refinery, Guwahati Refinery, Digboi Refinery, pipeline operators, and contracted tanker/logistics service providers. The figure of 3,345 workers reported for the Bongaigaon Refinery represents only one component of this aggregate.

The data in Table 2 demonstrates employment position across different segments of the oil and gas industry in Assam during the 2018-19 period. The total direct employment in the sector, comprising 57,800 persons, represents approximately 4.59% of the total organised sector employment in Assam. These figures emphasise the substantial role of the oil and gas industry as an employer in the state, particularly through contractual arrangements in the exploration, refining, and marketing segments.

Indirect Contributions of the Industry to Income and Employment Generation

The oil and gas sector in Assam extends its impact beyond direct economic contributions by generating substantial indirect effects on income and employment through backward and forward linkages with various industries (Bacon & Kojima, 2011). Backward linkages in the oil and gas industry refer to the dependence on other industries for the supply of goods and services required for its operations (Bangsund & Leistritz, 2007). This includes the procurement of machinery, chemicals, and equipment necessary for exploration, drilling, refining, and transportation. The growth of the oil and gas sector stimulates demand for heavy machinery, construction services, chemical inputs, and engineering services (Considine et al., 2010). These inputs are primarily sourced from industries such as manufacturing, engineering, and construction, leading to an economic ripple effect across these sectors (Hirschman, 1958). Forward linkages involve the utilisation of oil and gas outputs as inputs in other sectors (Miller & Blair, 2009). The products derived from crude oil, such as diesel, gasoline, jet fuel, and kerosene, are integral to the functioning of the manufacturing, construction, and transportation sectors (Bangsund & Leistritz, 2007). Additionally, by-products like paraffin wax and

asphalt are essential in industrial processes and infrastructure development.

Multiplier Effects and Employment

The indirect contributions of the oil and gas industry extend to significant employment generation through these backward and forward linkages[1] (Tang et al., 2013). Ancillary industries[2], including hospitality, real estate, and retail, also benefit from increased demand for goods and services (Tang et al., 2013). This creates secondary and tertiary employment, amplifying the overall economic impact of the sector (Considine et al., 2010). Workers in sectors supporting oil and gas operations, such as logistics, maintenance, and catering, benefit from the sector's growth, further contributing to income generation in the state.

The refining segment of the oil and gas industry in Assam generates significant indirect economic impacts, both during its construction and operational phases. The construction phase of a refinery is particularly labour-intensive, requiring substantial capital investment in materials, equipment, and services. This investment injects demand into the economy by driving expenditures on construction, plant machinery, and various services, thereby stimulating output, income, and employment. During the peak construction period, thousands of jobs are created directly and indirectly, significantly enhancing the economic activity in the surrounding areas.

In addition to job creation, the construction of refineries leads to increased demand for inputs from industries such as construction, heavy machinery, and technology. The multiplier effects from these activities result in greater income generation and tax revenues, providing a boost to the local economy. The economic ripple effect extends to service providers, including suppliers, transporters, and vendors, who support the refinery's construction. These industries benefit from increased demand for refinery-related components, building materials, and construction equipment. Once operational, refineries continue to drive indirect economic benefits. The production of petroleum and petrochemical products contributes to industrial output and generates a demand for intermediate products. Refineries purchase inputs such as chemicals, catalysts, and machinery from various sectors, which further stimulates production in other industries. The backward linkages associated with these inputs support a wide array of businesses, including equipment suppliers, construction services, and specialised maintenance services. Additionally, refineries indirectly contribute to industries like transportation, utilities, and banking by relying on these sectors for operational support. The indirect effects of refinery operations are measured in terms of job creation, tax revenue, and output growth in industries that supply goods and services to the refinery. As these industries experience higher demand, they too contribute to the economy by hiring more workers and generating further rounds of income. The broader economic ecosystem benefits from this cascading effect, leading to sustained growth in both direct and indirect sectors. Moreover, refineries play a pivotal role in supporting local businesses and infrastructure development in their vicinity. The emergence of refineries often leads to increased commercial activities such as road construction, markets,

[1] Backward and forward linkages capture how the growth of one industry stimulates economic activity and investment in other related industries (Hirschman, 1958). Establishment or expansion of an industry creates demand for inputs, raw materials, components, or services from supplier industries. These stimuli to the supplier industries are backward linkage effects. Production of an industry also provides inputs, products, and/or services for downstream industries that add value to these to enhance their own production. The resulting expansionary effect in the downstream industries is said to be caused by forward linkages.

[2] Expansion of production in any segment of the oil and gas industry generates demand for housing facilities for its employees, accommodation for others such as contractors and car operators, consumer goods including food, clothing, electricity and public transport and so on. As the provider of these items gain income, their income further generates the next round of demand for various goods and services. Thus, every unit of output in the oil and gas industry (for that matter, any industry) generates income and employment indirectly also through linkages with related industries.

restaurants, and other public services. These secondary developments further enhance the indirect economic impact of the refining segment, creating new opportunities in retail, hospitality, and other service sectors.

Estimation of the Indirect Impact

The indirect economic impacts of the oil and gas sector manifest through multiple rounds of economic activity as the sector demands goods and services from, and supplies products to, various industries. To quantify these effects, Input-Output (I-O) analysis serves as a robust methodological framework, offering insights into the interdependencies among economic sectors.

Given the lack of state-specific I-O tables for Assam, the study employs the 2013-14 all-India Input-Output Table as a proxy, under the assumption that technological structures and economic interrelations in the oil and gas sector have remained largely consistent (the limitations of this assumption are discussed above). The table disaggregates the sector into three relevant components: Natural Gas, Crude Petroleum, and Petroleum Products, enabling a granular analysis of their economic contributions.

Key multipliers derived from the I-O Table include **Income Multipliers**: 0.984 (Natural Gas), 0.973 (Crude Petroleum), and 0.954 (Petroleum Products). These indicate that each unit of output generates almost an equivalent amount of direct and indirect income. **Employment Multipliers**: 0.210 (Natural Gas), 0.117 (Crude Petroleum), and 0.122 (Petroleum Products), reflecting employment generated per unit of output (Singh & Saluja, 2018). The total income and employment generated were calculated by applying these multipliers to the output values of Assam's petroleum subsectors. The indirect impacts were estimated by subtracting the direct contributions from the total estimated impacts.

Before the results are presented, it is necessary to clarify how the direct employment figures used in the multiplier analysis relate to those reported above. Table 2 reports a total direct employment of 57,800 persons across all four segments of the industry (Exploration & Production, Transportation, Refining and Marketing), compiled from company records and surveys. The 2013–14 Input-Output Table, however, identifies the petroleum industry only through its production sectors (Natural Gas, Crude Petroleum and Petroleum Products); pipeline and road transportation, and the wholesale and retail marketing of petroleum products, are subsumed within the broader transport and trade sectors of the table and therefore have no petroleum-specific multipliers. Consequently, the multiplier analysis presented in Tables 3 and 4 is confined to two production segments: Crude Oil & Gas, covering the crude oil and natural gas production activities of the Exploration & Production segment (17,482 direct jobs), and Refining (9,977 direct jobs). Together, these account for 27,459 direct jobs. The Transportation (8,595 persons) and Marketing (17,628 persons) segments are excluded from the multiplier analysis to avoid applying production-sector multipliers to service activities that cannot be mapped reliably to the I-O classification. The figure of 27,459 jobs in Table 4 is therefore a subset of, and not an alternative estimate to, the 57,800 jobs reported in Table 2.

As summarised in Table 3, the oil and gas sector in Assam exhibited substantial income generation for the fiscal year 2018–19. The total direct and indirect income generated from crude oil and gas operations amounted to ₹36,819.55 crore, with direct income contributing ₹18,464.29 crore and indirect income generating ₹18,355.26 crore. Similarly, the refining segment yielded a total income of ₹37,297.29 crore, with direct contributions of ₹10,728.29 crore and indirect contributions reaching ₹26,569.00 crore. In total, the industry generated an overall income of ₹74,116.84 crore (approximately ₹741 billion), comprising ₹29,192.58 crore in direct income and ₹44,924.26 crore in indirect income.

The indirect contribution of the oil and gas industry to income generation in Assam amounted to approximately 13.88% of the state's Gross State Domestic Product (GSDP)

during 2018–19. This contribution exceeded the sector's direct contribution of 9.02% of GSDP, reflecting the substantial backward and forward production linkages generated through the industry's interactions with the rest of the economy. However, because national I-O coefficients do not account for the leakage of intermediate demand to other states and abroad, this figure is likely to overstate the indirect income retained within Assam (see above).

Table 3. Direct and Indirect Income Generated by the Oil and Gas Industry in Assam, 2018–19 (₹ crore)

Sector/Subsector	Direct and Indirect Income Generated	Direct Income Generated	Indirect Income Generated
Crude Oil and Gas	**36,819.55**	**18,464.29**	**18,355.26**
Refining	**37,297.29**	**10,728.29**	**26,569.00**
Total	**74,116.84**	**29,192.58**	**44,924.26**

Source: Author's calculation as per methodology outlined

Table 4: Direct and Indirect Generation of Employment in the Oil and Gas Industry of Assam in the year 2018-19

Sector/Subsector	Direct and Indirect Employment	Direct Employment Generated	Indirect Employment Generated
Crude Oil and Gas	**615,226**	**17,482**	**597,744**
Refining	**476,967**	**9,977**	**466,990**
Total	**1,092,194**	**27,459**	**1,064,735**

Source: Author's calculation as per methodology outlined

Note: Direct employment reported in this table includes only the Crude Oil & Gas and Refining sectors because Input-Output multipliers are available only for these production sectors. Consequently, the Transportation and Marketing segments included in Table 2 are excluded from the multiplier analysis. Therefore, the direct employment estimate in Table 4 (27,459 jobs) should not be directly compared with the overall direct employment reported in Table 2 (57,800 jobs).

Table 4 presents the employment impacts estimated using the Input-Output (I-O) framework. It is important to note that the analysis is restricted to the Crude Oil & Gas and Refining segments because the available 2013–14 Input-Output Table provides sector-specific multipliers only for these production activities. Consequently, the Transportation and Marketing segments are excluded from the multiplier analysis, although they are included in the overall direct employment estimates reported in Table 2.

Based on the I-O analysis, the two production segments directly generated 27,459 jobs, while indirect employment amounted to 1,064,735 jobs (approximately 1.06 million), resulting in a total employment impact of 1,092,194 jobs (approximately 1.09 million). Of the direct employment, 17,482 jobs were generated in the Crude Oil & Gas segment and 9,977 jobs in the Refining segment. The much larger indirect employment reflects the strong backward and forward production linkages of these sectors with the wider economy. As discussed above, these indirect estimates are derived from national coefficients and are therefore best interpreted as upper-bound approximations of the employment effects retained within Assam.

The direct employment estimate reported in Table 4 (27,459 jobs) therefore differs from the

57,800 jobs reported in Table 2 because the latter represents total direct employment across all four segments of the oil and gas industry, Exploration & Production, Transportation, Refining, and Marketing, whereas Table 4 includes only those sectors for which Input-Output multipliers are available. The exclusion of the Transportation and Marketing segments from the multiplier analysis avoids applying multipliers to sectors that cannot be reliably mapped to the Input-Output classification and ensures methodological consistency.

The magnitude of indirect impacts highlights the oil and gas industry's integral role in driving Assam's economic growth. Backward linkages, such as demand for machinery, chemicals, and construction services, stimulate production in supporting industries, while forward linkages ensure the flow of refined petroleum products into transportation, manufacturing, and other sectors. These multiplier effects amplify the sector's economic footprint far beyond its direct contributions.

Contribution of the Industry to the State Exchequer

The oil and gas industry holds an important role in Assam's fiscal architecture, primarily through its substantial contributions in the form of royalties, sales taxes, value-added taxes (VAT), electricity duties, entry taxes, and other levies. While the central government collects Union Excise Duties and customs duties, the state's revenue accrues mainly from non-GST sources such as petroleum sales and royalty payments. The continued exemption of key petroleum products from the Goods and Services Tax (GST) has allowed Assam to retain control over significant tax revenues from this sector. Major operators, including OIL, ONGC, IOCL and NRL, are among the largest contributors.

Following a policy change in February 2014, royalty payments have been calculated based on pre-discount (gross) prices, resulting in increased fiscal inflows to the state. In financial year 2018–19, OIL alone contributed ₹1,899.18 crore in royalties, while ONGC added ₹455.49 crore. In addition, OIL and NRL paid ₹760.13 crore and ₹12 crore, respectively, in sales tax. Central Sales Tax (CST) collections from these entities amounted to ₹462.66 crore, and other revenue streams such as entry tax and electricity duties brought in smaller but non-negligible sums.

The cumulative fiscal contribution of the industry in 2018–19 stood at ₹4,086.24 crore—constituting approximately 29.08% of Assam's total state revenue. Over the five-year period from 2014–15 to 2018–19, the sector consistently accounted for between 29% and 37% of the state's total revenues. This consistency underscores the strategic economic importance of the oil and gas sector to Assam's public finances.

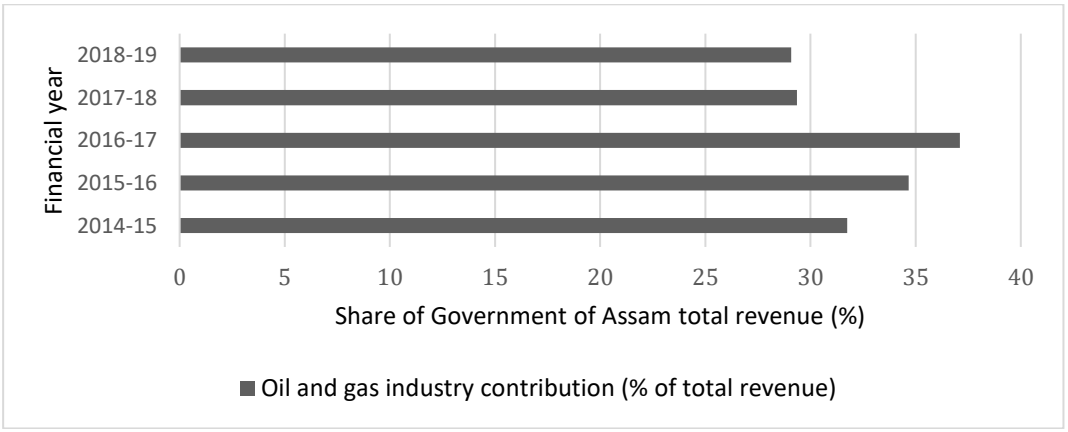


Figure 1: Contribution of Oil Exploration & Production Companies and Refineries to the State Exchequer as a Percentage of the Government of Assam's Total Revenue, 2014–15 to 2018–19

Note: The horizontal bars show, for each financial year (April–March) from 2014–15 to 2018–19 (vertical axis), the combined payments of royalties, sales tax/VAT, Central Sales Tax, entry tax, electricity duty and other levies made by the oil exploration and production companies (OIL and ONGC) and the refineries (the IOCL refineries and NRL) to the Government of Assam, expressed as a percentage of the state government's total revenue receipts (horizontal axis). Values: 2014–15, 31.75%; 2015–16, 34.67%; 2016–17, 37.06%; 2017–18, 29.36%; 2018–19, 29.08%.

Figure 1 illustrates the sustained fiscal contributions made by oil exploration and refining companies over time. The peak contribution of 37.06% in FY 2016–17 can be attributed to favourable global oil prices and increased production, alongside the adoption of pre-discount pricing in royalty computation. Despite some fluctuations, the sector's contribution has remained above 29% annually, reflecting a relatively stable source of income for the state government. The fiscal contribution estimated in this study reinforces previous observations regarding the strategic importance of the petroleum industry for Assam's public finances (Sarma, 2004). However, while earlier studies largely provided descriptive accounts of royalty payments and taxation, the present analysis quantifies the industry's overall fiscal contribution by combining royalties, Value Added Tax (VAT) and other levies. The finding that nearly one-third of the state's revenue originated from the petroleum sector during 2018–19 demonstrates the continuing fiscal dependence of Assam on hydrocarbon resources. This also implies that any long-term decline in petroleum production or transition towards cleaner energy sources could have important implications for the state's fiscal sustainability.

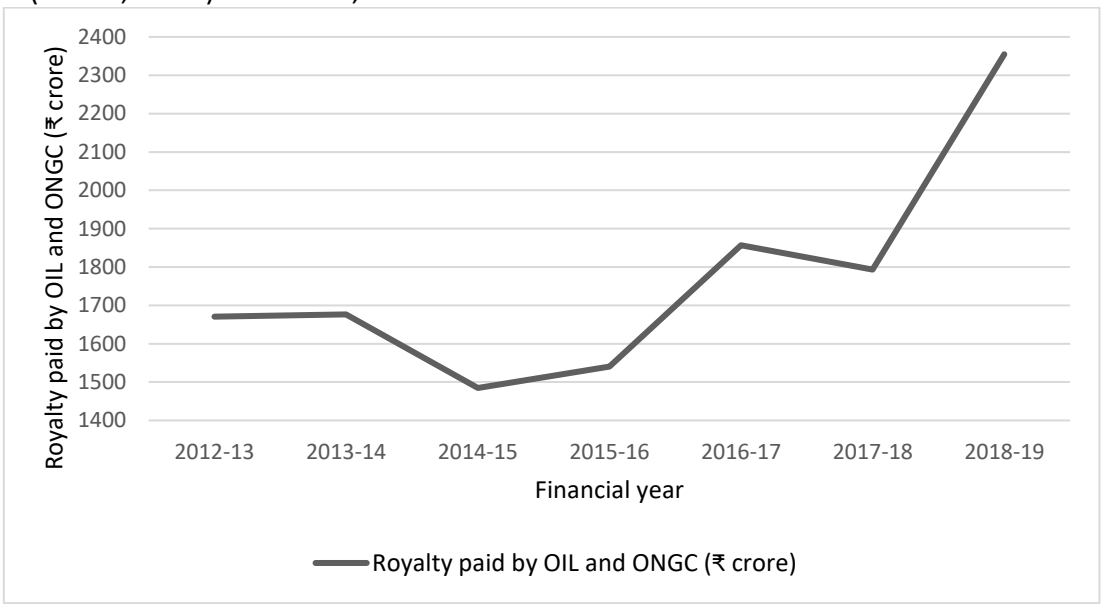


Figure 2: Trend of Royalty Paid by OIL and ONGC to the State Exchequer, 2012–13 to 2018–19 (₹ crore)

Note: The line shows the total royalty on crude oil and natural gas paid by OIL and ONGC to the Government of Assam in each financial year (horizontal axis), in ₹ crore at current prices (vertical axis; the axis begins at ₹1,400 crore). Values: 2012–13, 1,670.64; 2013–14, 1,676.84; 2014–15, 1,484.61; 2015–16, 1,540.09; 2016–17, 1,856.35; 2017–18, 1,792.98; 2018–19, 2,354.67.

Figure 2 details the trend in royalty payments from OIL and ONGC between FY 2012–13 and FY 2018–19. Total royalties increased from ₹1,670.64 crore in 2012–13 to ₹2,354.67 crore in 2018–19. This growth is largely attributable to policy reforms and improved crude oil pricing mechanisms, particularly the shift to gross pricing.

Conclusion

The findings of the study provide empirical evidence that the oil and gas industry continues to occupy a central position in Assam's economy through its contributions to income generation, employment creation and public finance. Consistent with earlier studies that recognised the strategic importance of petroleum resources in Assam (Bhattacharya & Datta, 2004; Gogoi, 2012), the present study finds that the industry directly contributed about 9% of the state's GSDP and nearly 29% of total state revenue during 2018–19. However, unlike previous studies that primarily focused on individual enterprises, financial performance or historical development of the industry, this research provides a comprehensive assessment of both direct and indirect economic impacts by

integrating all major segments of the petroleum value chain.

The Input-Output analysis further demonstrates that the industry's indirect effects exceed its direct contributions in both income and employment generation. These findings support international evidence that petroleum industries generate substantial multiplier effects through extensive backward and forward linkages with manufacturing, construction, transportation and service sectors (Bacon & Kojima, 2011; Bangsund & Leistritz, 2007). Thus, the economic significance of Assam's petroleum industry extends well beyond its own production activities. Since these indirect effects were estimated using national I-O coefficients, they should be regarded as upper-bound estimates; future research based on a regionalised or survey-based input-output table for Assam would help to refine them. The study therefore contributes to the existing literature by providing one of the first comprehensive estimates of the aggregate economic contribution of Assam's oil and gas industry, combining direct value addition, employment, fiscal contribution and Input-Output multiplier analysis within a single analytical framework.

Thus, from the enclaved industry of the colonial period, the industry has evolved over the decades to integrate into the mainstream of the economy of Assam. As of 2019, Assam had 158.62 million metric tonnes (MMT) of crude oil and 170.71 billion cubic metres (BCM) of natural gas as balance recoverable reserves (CEIC, 2021). These amounted to 25.63% and 12.36% of the country's crude and gas reserves, respectively. As per these estimates, there are enough gas and oil reserves in Assam to feed the petroleum industry in the state for many more years to come. Yet it is difficult to say that the industry has a bright future in the state. Having recoverable reserves and actually drawing up the reserves are two different things due to a variety of factors, including non-upgradation of technology, remoteness of locations where drilling and mining are to be carried out and resistance to expanding exploration, drilling and mining on social and environmental grounds ("AASU Protest Disrupts," 2024; Singh, 2024). Consequently, three of the four refineries located in the state are now fed with imported crude. Further, with hydrocarbons labelled as dirty sources of fuel in the context of climate change, the petroleum industry is globally facing a sunset. The available reserves of natural gas and crude oil should be viewed as a stock for sustaining the industry for some more time, which can be used for developing alternative economic activities in the state which will be necessary to make up for the loss in income and employment generation due to the decline in the petroleum industry in the future.

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Ethical Approval

This study is based primarily on secondary data obtained from publicly available reports, official statistics, and industry documents. Semi-structured interviews were conducted with company officials, contractors and service providers in their professional capacity to obtain institutional information only; they did not involve human subject experimentation or the collection of personal or sensitive information. Participation was voluntary, oral informed consent was obtained, and the identities of respondents are not disclosed. Therefore, formal institutional ethical approval was not required.

Conflict of Interest

We declare that there are no conflicts of interest, financial or non-financial, in relation to the content of this study.

Author Contributions

Author 1 conceptualised the study, developed the research design, conducted the empirical analysis, and prepared the initial draft of the manuscript.

Author 2 contributed to data collection, compilation of industry statistics, and preliminary analysis of employment and sectoral linkages.

Author 3 provided methodological guidance, supervised the research process, and contributed to the interpretation of results and revision of the manuscript. All authors reviewed and approved the final version of the manuscript.

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Data Availability Statement

The data supporting the findings of this study will be made available upon request.

Informed Consent

Oral informed consent was obtained from all interviewees before the interviews. No personal or identifiable information was collected, and respondents are not identified in the manuscript.