



Natural gas supply and the Nigerian State

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Abstract

The study examined Nigeria’s natural gas supply in relation to selected similar economies within and outside Africa, aiming to identify the reasons behind the sub-optimal gas production in the country. The research adopts an expository approach, describing and comparing the natural gas sectors of Nigeria, Algeria, Egypt, and Australia. The findings affirm that Nigeria possesses approximately 5,748 km³ (206.5 Tcf) of gas reserves, yet its gas supply does not match its resource endowment, primarily due to inefficiencies in production, as evidenced by the country's high reserve-to-production ratio. Nigeria’s average annual production is estimated at around 1.5 Tcf, representing about 0.73 percent of its reserves annually, with a reserve-to-production ratio of approximately 133 years. In comparison, Algeria has a reserve of 4,502 km³ (159 Tcf) and an average annual production of 3.53 Tcf, resulting in a reserve-to-production ratio of 45 years. Egypt’s reserves amount to 2,200 km³ (78 Tcf), with an annual production of approximately 2.12 Tcf, translating to a reserve-to-production ratio of 36.8 years. Australia holds a gas reserve of 3,228 km³ (114 Tcf) and produces about 5.3 Tcf annually, which corresponds to a reserve-to-production ratio of roughly 21.5 years. Paradoxically, Algeria, Egypt, and Australia, despite having smaller reserves and facing similar political and economic challenges as Nigeria, produce more gas. Natural gas, being a transition fuel, can assist Nigeria in reducing its carbon emissions in line with the Paris Agreement, while also offering other benefits. However, Nigeria may continue to face environmental hazards and air pollution due to neglect in the sector. Addressing production inefficiencies remains crucial for improving the sector’s performance and environmental sustainability.

Keywords: Challenges, gas flaring, gas supply, growth, Nigeria, transition fuel, R/P ratio.

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Contribution of this paper to the literature

Studies focused on addressing challenges in Nigeria's natural gas sector have largely been conducted in isolation, without reference to or comparison with similar nations facing comparable political and socioeconomic challenges. Other countries facing similar issues are producing more gas, which highlights the sub-optimal performance of Nigeria's gas sector.

1. Introduction

1.1. Background

Nigeria holds a pivotal position in the global energy landscape due to its vast natural gas reserves, with proven reserves exceeding 206 Tcf. The abundant gas reserves place the country in an advantageous position within the global energy market (Sakib, 2021). While the country is a key supplier of liquefied natural gas (LNG) to markets outside Africa, such as Europe and Asia, its West African Gas Pipeline (WAGP) and the proposed Trans-Saharan Gas Pipeline initiatives play a strategic role in the global gas market. Natural gas, which is a relatively cleaner energy source compared to crude oil, promises economic and industrial growth, sustainable energy utilization, and ensures the expansion of global energy supply. The intensive use of natural gas in Nigeria has been primarily in thermal electric power generation, industrial activities, and household cooking and heating (Areremi & Emaviwe, 2023). While the development of Nigeria's natural gas sector has been influenced by an incongruent mix of structural, economic, and governance factors in the past, the sector is gradually taking shape given the energy-specific policies now in place. The Petroleum Industry Act (PIA) of 2021 is a major milestone in this regard. The Act promises the reformation of the oil and gas sector while creating a transparent and level playing field for investors (Malberg, 2024).

Nigeria is identified as experiencing energy inadequacy, with approximately 40 percent of its citizens lacking access to clean, reliable, and efficient energy sources (Olujobi, Yebisi, Patrick, & Ariremako, 2022). Natural gas represents a reliable means to address the shortfall. This has formed part of the basis upon which the national government pushes for infrastructural development. The environmental dimension of Nigeria's natural gas sector cannot be overlooked. Although natural gas is known for being relatively cleaner than other hydrocarbons, its extraction, flaring, processing, and transportation exhibit certain environmental traits. In the bid to expand its natural gas sector, it is essential to balance the costs and benefits of gas exploration. This requires assessing the economic, environmental, and human welfare impacts of the process.

1.2. The Nigerian Gas Industry Trajectory

The bid to expand the natural gas supply and improve efficiency through the pipeline network prompted the introduction of the Gas Master Plan, 2008. The plan aimed to enhance investment in Nigeria's gas industry and promote adequate supply for domestic use, power generation, and industrial purposes across the country (Okotie, Ogbarode, & Ikporo, 2018). The plan further focused on the eradication of gas flaring, with favorable projections for its utilization (Oruwari, Salihu, & Obunwa, 2024). Although the effort was stalled by militancy in the Niger Delta and government inconsistency, the reform gained momentum in the 2000s with increased participation from both foreign and local investors. Joint ventures and partnerships led to significant growth in infrastructure projects, including the West African Gas Pipeline, which supplies gas to Ghana, Togo, and the Republic of Benin. Currently, the country is a key player in the production and export of liquefied natural gas (LNG) in Africa through the Nigeria LNG Limited (NLNG) facility at Bonny Island. The facility has resulted from several efforts to position Nigeria as a formidable force in the international LNG market (Mmesomachukwu & Uchechukwu, 2024).

The country's gas industry has undergone significant progress since its discovery. Nigeria initially discovered natural gas alongside crude oil during the early part of the 20th century but did not commence commercial production until the 1970s (Okotie et al., 2018). Undoubtedly, the country is globally recognized for its extensive reserve base located in the Niger Delta (Sakib, 2021). Natural gas constitutes the majority of Nigeria's energy mix and supplies most of the country's electricity. Its significance has prompted Nigeria to develop various policies and strategies for the development and utilization of natural gas. These include, but are not limited to, the Nigerian Gas Flare Commercialization Programme (Malberg, 2024). The programmes were targeted towards promoting domestic gas use and investing in the gas sector both domestically and internationally, while also reducing flaring (Romsom & McPhail, 2021). Although efforts have been made, Nigeria is still confronted with challenges towards harnessing the maximum potential of its natural gas. Infrastructural dilapidation, regulatory issues, security challenges, and volatility of world energy prices are part of the hindrances to the attainment of the sector. Having a stable and sustainable natural gas industry that will spur economic development is therefore a way forward to overcome the challenges (Olujobi et al., 2022). Natural gas production in the country is concentrated in the Niger Delta area. A significant portion of Nigerian gas is either flared or reinjected, partly due to inadequate infrastructure and market constraints, and to facilitate crude oil extraction from the well. The supply of natural gas in the country is being increased through the construction of gas processing plants, pipelines, and export terminals by the government (Olujobi et al., 2022). The Nigerian Liquefied Natural Gas (NLNG) project is one of the largest projects in the world and a driving force for Nigeria's gas supply chain (Adekoya, Ogunbowale, Akinbayo, & Al-Faryan, 2025). The NLNG project has indeed expanded Nigeria's natural gas processing and export capacity as well as generated revenue for the country. Apart from LNG exports, Nigeria also aims at developing domestic gas supply for power generation, industrial use, and domestic consumption (Areremi & Emaviwe, 2023). The Ajaokuta-Kaduna-Kano (AKK) pipeline and the Escravos Gas Processing Plant expansion are among the projects aimed at increasing domestic gas supply while reducing gas flaring (Bello & Dauda, 2022).

Efforts so far notwithstanding, the lack of an intact gas supply chain has caused a disjointed energy market, with players operating in silos that are not coordinating with each other. The fragmentation hinders efforts to achieve supply and demand maximization, as individual sectors compete for available resources in the absence of coordination (Nduka et al., 2020). Lack of collaborative platforms among stakeholders prevents the development of a unified national energy policy that is capable of addressing these issues effectively. Additionally, the prevailing pricing mechanisms for natural gas do not stimulate exploration and investment in the sector (Abdullahi, Nteegah, & Kalu,

2024). The continuous application of subsidies to keep prices low may look beneficial in the short term but ultimately stifles growth. Investors are sure to be discouraged from participating in an unpredictable market with hidden true costs of production and sales. This low incentive has pushed substandard investments into critical infrastructure that is supposed to enhance capability for supply to better adjust to rising requirements for demand. In this process, the natural gas sector is unable to coordinate with demand and rising requirements for consumption, since these result in constant shortages and incompetence in sales (Mmesomachukwu & Uchechukwu, 2024). Investors, on the other hand, tend to be discouraged and hindered by difficulties in working with the regulatory framework, given the discouraging potential investment in the natural gas sector (Olujobi, 2021). In addition, socio-political issues greatly complicate the challenge of establishing a uniform national strategy for the natural gas sector. Conflicting stakeholders' interests have also led to fragmented strategies that do not address the overall aims of energy security and the country's growth (Obaka & Ogboru, 2021).

2. Gas Supply Trends in Nigeria

2.1. Associated Gas

Nigeria is endowed with one of the world's largest proven gas reserves, estimated at more than 200 Tcf. The country's natural gas supply derives from associated and non-associated natural gas sources (Ayodele, 2024). Associated gas comes along with crude oil deposits. Nigeria, being a large exporter of crude oil, extracts a good portion of its natural gas along with oil (Arowolo & Perez, 2020). When oil is pumped from the ground, gas is often released as well. Historically, this gas was frequently flared, meaning it was burned off as a waste product during oil extraction due to the lack of infrastructure and technology for its capture and utilization. This practice not only wasted a valuable resource but also contributed to environmental pollution, making it a point of concern for both the government and environmental advocates (Aniebo & Mogbo, 2024). Figure 1 shows the total and percentages of associated gas flared in Nigeria over the last three years.

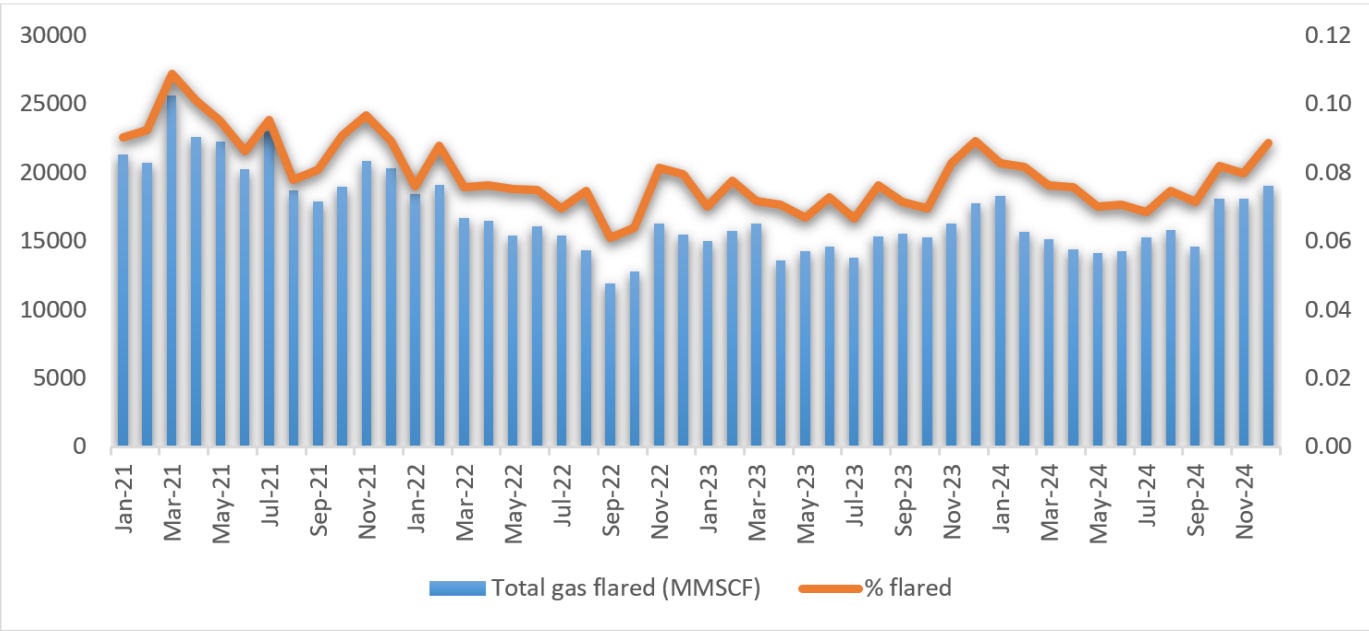


Figure 1. Total and percentage of associated gas flared in Nigeria.

Source: Nigeria Upstream Petroleum Regulatory Commission (NUPRC), 2025.

The amount of total flared gas was high at the beginning of 2021, with March 2021 registering the highest figure at 25,645.67 MMSCF. This peak was succeeded by irregular levels in subsequent months, and August 2021 saw a sharp fall to 18,704.01 MMSCF. The rate of flaring is observed from the figures to have been at a high rate during the early period, while a steady downtrend was observed in 2022 and 2023. For example, June 2022 saw a total volume of flared gas of 16,056.03 MMSCF, and for the whole of 2023, the volumes ranged steadily between 14,000 and 16,300 MMSCF. Statistics for 2024 also illustrate this trend, with 18,308.19 MMSCF flared in January. This decrease in overall gas flared supports the contention that there have been improvements in gas management methods, more infrastructure, or enhanced efficiency regarding gas capture. Aside from the overall gas flared, the percentage of gas flared relative to overall gas production is another form of analysis. This percentage determines the effectiveness of gas utilization in oil production. The flare gas rate throughout the observation period was mostly low and fluctuated between 0.06 percent and 0.11 percent. In March 2021, for instance, 0.11 percent of the produced gas was flared, but over the remaining years, the rate fluctuated between 0.06 percent and 0.09 percent. This degree of consistency in low rates demonstrates that Nigeria has achieved significant progress in gas recovery and utilization instead of flaring. The period between 2022 and 2023 was also characterized by high commitment toward flaring reduction, with percentages in nearly all but a few months being less than 0.10 percent. The trend indicates effective regulatory intervention and infrastructure build-up along the lines of global best practices for environmental footprint reduction.

2.2. Non-Associated Gas

Non-associated gas is present in reserves with little or no crude oil content. Just like the associated gas reserves, these deposits are predominantly found in the Niger Delta and offshore areas. Non-associated gas is produced from gas fields that are developed for gas production purposes. They serve the same functions as associated gas for residential use, power generation, and exportation. The focus on the development of non-associated gas fields aligns with Nigeria's overall energy policy, aiming to maximize the development of its extensive gas reserves (Ojeyinka & Aliemhe, 2023). The effort in this regard also includes the bid to transition to cleaner energy use in line with the

global mission of the 2023 United Nations Climate Change Conference (COP28) (Yahaya, Obansa, & Abdullahi, 2023).

To derive maximum value from natural gas, Nigeria has invested in gas processing plants that strip valuable constituents from raw natural gas. The plants extract liquids such as propane, butane, and ethane that are recoverable as fuel or petrochemical feedstock (Yahaya et al., 2023). The facility has positioned Nigeria on the LNG producers' map of the world. Nigeria has also accessed regional sources of gas under its gas supply development strategy. The West African Gas Pipeline from Nigeria to other neighboring countries like Ghana, Togo, and Benin is a good example of a giant regional project gas piping outside Nigerian borders. Apart from supplementing Nigeria's supply of gas, it also helps in regional integration of energy and therefore expands Nigerian natural gas's market (Udoudo, Kalu, & Oduola, 2023).

3. Challenges to the Supply of the Natural Gas Sector in Nigeria

Regulatory inconsistency and lack of transparency are major obstacles to efficient supply and demand balancing of gas in Nigeria. In most nations, the regulatory framework in the natural gas industry is opaque and dispersed, with several agencies regulating various aspects of production and delivery (Ojeyinka & Aliemhe, 2023). This absence of coordination can potentially result in inefficiencies, compliance problems, and additional costs for producers. Additionally, frequent changes in policies or the introduction of whimsical regulations might confuse investors. When business entities perceive the regulatory environment as uncertain, they are more likely to be discouraged from investing, which hampers investment in infrastructure and capacity for efficient production. The lack of a robust regulatory system that can instill confidence in investors and ensure long-term stability in the gas market remains a significant challenge (Karkare, Odijie, Ukaoha, & Van Seters, 2022).

Price volatility is a concern in the development of the Nigerian gas market as it affects gas supply and demand stabilization. Price volatility in the global gas market can directly affect domestic markets, determining the levels of consumption and production. When prices are rising disproportionately, consumers may substitute other alternatives and reduce the demand for natural gas. Producers, in turn, can reduce production when prices drop, perhaps reducing future supplies. Volatility can be a source of uncertainty in determining investment and production. In response to these risks, players must devise mechanisms to insulate against price volatility, for instance, through long-term contracts or hedging instruments that introduce stability to producers and consumers (Akinrele, 2016).

4. Literature Extract

The neoclassical theory outlines the process of attaining a steady economic growth rate given a combination of capital, labour, and technology. When capital and labour are combined in varying proportions and in the presence of technology, an equilibrium state can be achieved. The role of technology in the production process is to determine the effectiveness with which other inputs are produced. Hence, as technology changes over time, it influences the productivity of the inputs in the production function (Romer, 2011). The theory, however, expounded on the difference between temporary and long-term steady states while emphasizing the importance of capital accumulation and its usage for growth purposes within the economy. This, therefore, shows that the relationship that exists between capital and labour, as augmented by technology, determines the output level in the country (Todaro & Smith, 2009). Therefore, natural gas may be said to be produced with a combination of labour and capital given the interaction of technology in an aggregate production function where the elasticity of substitution is asymptotically equal to one (Romer, 2011).

The major assumption of the neoclassical growth theory is that all workers are identical (that is, being homogeneous, which cannot be so in reality); the aggregate production function (output) is related to two inputs, and there is only one single output in the economy. The capital-labour ratio is assumed to change over time. Hence, there is no perfect substitutability of capital and labour. Assuming government activities are absent, there would be no allowance for the business cycle to cause fluctuations in employment. The rate of savings in production growth is assumed constant; time is assumed continuous under the Solow model, and labour and knowledge grow at a constant rate (Todaro & Smith, 2009). The advantages of standard neoclassical growth theory are that the model makes use of two inputs which are the major factors of production. It also assumes that there would be no fluctuation in the economy in the long run and the model believes that savings will lead to capital accumulation. The limitations of standard neoclassical growth theory are that it emphasizes two sources of growth that have a difference in capital per labour but growth can be sourced from outside; the theory does not identify the effective labour and how it can be efficiently measured. Also, the exclusion of natural resources, government activities, and external trade renders the theory unrealistic.

The empirical work by Nduka, Obibuike, Onyejekwe, Kerunwa, and Ekwueme (2021) emphasizes the importance of efficient pricing mechanisms to enhance domestic gas supply in Nigeria. The study confirms that revenue from gas flaring exceeds revenue from domestic gas supply obligations, suggesting that companies have an incentive to prioritize gas flaring over meeting domestic needs. This disclosure underscores the urgency of regulatory reforms for domestic gas supply to meet local demands and ensure environmental sustainability. Yahya (2018) also contributes to this discussion by examining the relationship between gas prices and demand. Using a structural vector autoregressive (S-VAR) model, the study establishes that gas prices play a decisive role in determining gas demand and, consequently, economic production. This interface necessitates the establishment of a pricing framework that stabilizes market forces without undermining local demands. As Nigeria continues its transition to maximize its position in the global energy market, the importance of liquefied natural gas (LNG) exports increases.

Udoudo et al. (2023) discussed the impact of LNG exports on the Nigerian economy using an ARDL model. They stated that LNG exports have a strong and significant positive impact on economic performance; thus, LNG should be included in the economic policy of Nigeria. Similarly, the study of Udoudo et al. (2023) presents the argument in the same light, where they investigate the correlations between LNG exports, Brent crude oil price, and inflation. The study addresses various LNG export effects on inflation dynamics and suggests that policymakers should consider the interactions while constructing economic policies.

Akinleye and Ekpo (2013) examined the influence of specific exogenous oil price shocks on the external sector of Nigeria using 10 behavioural equations in a Structural Macroeconomic Model. Quarterly data from 1981 to 2015

were analyzed in the study. The study discovered that oil price fluctuations never had a significant effect on variables adopted to proxy for Nigeria's external sector. However, it was found that movements in oil prices determined the extent of the country's total revenue, reflecting a high dependence on crude oil revenue. The study suggested the need for diversification into the real sectors of the economy while ensuring the continuous production of the oil sector.

The approaches used in different studies vary, resulting in a dense tapestry of analytical models that add depth to the understanding of Nigeria's natural gas dynamics. The application of VAR models, ARDL approach, VECM, and descriptive analysis reflects the complexity of the interactions being analyzed. For instance, the VAR model used by Akinleye and Ekpo (2013) allows examination of interdependence among various economic variables, while the ARDL approach used by Abdullahi et al. (2024) enables analysis of long-run equilibration relationships between petroleum prices and inflation. However, the variation in methodologies presents challenges. Different analytical frameworks yield different results, making it difficult to draw coherent conclusions. For example, although some research indicates that natural gas consumption is highly linked to economic growth, others highlight the complexities and subtleties involved in these associations. This variance necessitates a comprehensive strategy that considers Nigeria's unique socio-economic conditions when interpreting results.

5. Discussion

The requirement to transition into the adoption of cleaner energy through natural gas usage requires more efficiency than gas reserve abundance. This translates into the ability to produce higher and sustainable volumes of natural gas in relation to the reserves, measured by the reserve-to-production (R/P) ratio (Jimoh, 2025). The fact remains that the abundance of gas reserves in Nigeria has not translated into effective and efficient usage, hence the country's higher reserve-to-production ratio. Nigeria sits on proven natural gas reserves of about 5,748 km³, translating to 206.5 Tcf. Its annual average production, estimated to be approximately 1.5 Tcf, represents 0.73 percent of annual production and a reserve-to-production ratio of approximately 133 years. This is a significant reserve relative to the country's gas production. When the country's population, energy requirements, and other developmental goals are put into perspective, this is below expectations. Algeria has a lesser reserve of about 4,502 km³ (159 Tcf), with an average gas production of 3.53 Tcf. This is approximately 22 percent of their gas reserve being produced annually and a reserve-to-production ratio of about 45 years (EIA). Egypt has less than half of Nigeria's gas reserve (2,200 km³, and 78 Tcf). It produces approximately 2.12 Tcf in 2023, which is about 36.8 years of their reserve. Absolutely and relatively, these economies are efficient in their production regardless of their lesser gas reserves. Outside Africa, Australia has a gas reserve of 3,228 km³ (114 Tcf), a reserve slightly above half of Nigeria's. Their average annual production is 5.3 Tcf, meaning that about 4.65 percent of their gas reserves is being produced annually with a 21.5-year reserve-to-production ratio.

While the country's oil and gas sector may have faced a number of challenges, no sufficient explanation may be offered for its inadequacy in gas supply. In addition to infrastructure deficits, flaring has been a long-standing challenge, claiming 188 Bcf of gas production in 2022 alone (BP Statistical Review, 2024). Pipeline vandalism and other attendant challenges may also be attributed to production inefficiency. However, other economies face their respective challenges as well, although they differ in nature. Politically, Algeria is a nation that lacks transparency and suppresses the truth, with no major source of revenue other than its oil and gas sector. It mirrors Nigeria in its struggle for diversification, security issues, regional instability, and insurgency (BP Statistical Review, 2024). Just like Nigeria, the Australian economy also has a high and rising public debt profile, while relying on withering and polluting infrastructure, among others. These challenges never impede their efficiency in gas production despite the fact that they have smaller reserves in comparison with Nigeria. The Nigerian situation has demonstrated that, however pragmatic the policies made are, they may not make much difference if practicality lacks. Records have already shown that a myriad of policies have been tested, governments have changed hands, and energy leaders have lent their expertise, all to no significant effect.

Natural gas, being a transition fuel, can aid the country in reducing its carbon emissions in line with the Paris Agreement, while also providing other attendant benefits. Nigeria may still suffer longer environmental hazards and air pollution given the neglect that the sector suffers. However, the country's inefficiency issue is therefore surmountable as it only lacks an appropriate practical approach.

6. Conclusion and Recommendation

Nigeria's gas supply has clearly not represented its endowed reserves due to daunting factors that have received varied attention from the government. Countries with lesser natural gas endowments, within and outside Africa, have been found to exhibit relatively higher production efficiency, despite the political and economic challenges they also face, just like Nigeria.

Nigeria's gas production would turn around when the government and other stakeholders press beyond mere bureaucratic approaches and paper policies to real head-on tackling, as may be uniquely required by each of the challenges, as enumerated.

- i. The country needs to prioritize the enhancement of gas production and its value-chain infrastructure. The challenge needs to be given all-round attention by exploring private sector partnerships.
- ii. The sector requires the implementation of pragmatic and consistent policies that remove unnecessary bottlenecks and attract investment across the gas value chain in the country.
- iii. Security fortification of gas infrastructure against theft and vandalism to include technology-driven monitoring systems, while also engaging communities where facilities are situated.
- iv. In addition to developing expertise and adopting required technology, the country can adapt and replicate efficient production templates from similar economies to boost production.

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