

Article

Industrial Production Networks and Small Towns: A Case Study from Algeria

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Abstract: This paper investigates the conditions and consequences of integrating small towns into industrial production networks. It is based on empirical research conducted in Algeria, a hydrocarbon-dependent rentier economy characterized by significant regional inequalities and the political aims of economic diversification and spatial rebalancing. Elaborating the case study of a state-owned cement factory in the small town of Sigus, the research provides insights into the multiple roles of the state in shaping production network integration and the characteristics of small towns as economic locations. The methodology combines secondary data and information with primary research based on semi-structured interviews. It reveals the importance of a multi-scalar regional framework in production network integration, whereby national factors played a key role due to the centralized Algerian state, the state-owned character of the investing company, and the shortcomings of the small town's local environment. It emphasizes the contradictory impacts of production network integration in economic, social, and environmental terms, primarily on a local level. These contradictions underscore the necessity for critical evaluations to maximize the benefits of production network integration while mitigating its adverse effects. They also call for the more consistent involvement of the local community in similar economic development decisions. Notably, this research contributes significantly to the existing body of literature by addressing the underexplored topic of integrating small towns into production networks within the Algerian context. Doing so offers a more nuanced understanding of the particular economic, social, and environmental dynamics at play in these locations, thereby enriching the discourse on economic development strategies for small towns in rentier economies like Algeria.



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Keywords: production network; cement industry; state-owned enterprise; small town; Algeria

1. Introduction

Spatially fragmented production systems, including several enterprises and institutions from different regions and countries grouping around the same products, often called as (global) production networks, are the key elements of the contemporary economy [1]. Production network integration is mostly regarded as a national and local development tool. However, the way of integration is a key factor that determines development outcomes [2]. Roles in the value chain—whether upstream in high-value activities like research and design or downstream in lower-value activities like assembly—significantly influence their economic benefits, underscoring the uneven distribution of gains [3] examined by both the global value chain (GVC) and the global production network (GPN) literature. GVC/GPN research focuses on the organization (relations and power inequalities) of these structures [4,5] and on the changing positions (up- and downgrading) of the participants [6,7] while attempts to understand the dynamics and development effects of these networks. The concept of spatial embedding puts production networks into space while emphasizing that spatial qualities have an influence on the formation of these structures and vice versa [8]. However, it must be emphasized that beyond global production networks, we can find

similar structures organized on a regional or national scale. The importance of the latter ways of production seems to be appreciating due to the recent deglobalization trends fed by a mixture of factors, including geopolitical tensions and development strategies targeting own manufacturing capacities [9,10].

The interactions between (global) production networks and local economies are described by the concept of strategic coupling [1]. It is based on intentions and complementarities between the needs of production networks reflected in the strategies of the participants and the regional assets, including natural, human, infrastructural, industrial, and institutional factors [11]. According to GPN theory, regional assets and institutions can be interpreted as a multi-scalar system of supranational, national, and subnational factors playing different roles in several locations [12]. Regional institutions (e.g., national and local development agencies) can strengthen the complementarity by shaping the assets (location factors) according to GPN participants' needs, but they can also work for decoupling. In this way, different and changing modes of strategic coupling and a mixture of coupling, decoupling, and recoupling tendencies exist [13]. Regional development effects include "dark sides" like limited value added and capture or high risk of dependence and decoupling as well. Outcomes partially depend on hard-to-reproduce quality factors that often root in the local environment [5,14,15]. Although several case studies have been elaborated in the last two decades distinguishing different ways of strategic couplings and their consequences, they mostly concentrate on regions in core economies or in emerging Eastern Asia and do not really consider location differences in the settlement network.

Small towns that are in the focus of this research often are centers of the rural space; their production network integration can be regarded as an option for rural economic development. However, there are challenges in small towns in terms of the above-mentioned hard-to-reproduce quality location factors compared to large urban regions that can have negative effects on the quality and the outcomes of their production network integration. Their smaller size and limited agglomeration economies, including supporting institutions, hinder labor market matching, input sharing, and innovation [16]. These towns often rely on a single economic sector and lack the infrastructure and human capital to tackle economic and social challenges [17]. However, local shortcomings can be counterbalanced by "borrowed size" and "global pipes" ensured through geographical and network proximities. The first option happens if small towns are parts of larger agglomerations [18]. The second one includes the integration into different social, economic, and institutional networks that function as pipes of new knowledge and support local renewal [19]. As these points show, small town character seems to be not determining: the local capacity to act and a successful embedding in the multi-scalar institutional framework can result in unique development paths [20,21].

However, beyond the local context offering both challenges and possibilities, economies of small towns are co-shaped by their regional and national environment, including historical-cultural and socio-economic factors, particularly in the emerging economies [22]. According to Hinderink and Titus [23], small towns in Asia, Africa, and Central America depend more on regional and national economic and policy frameworks than on their own features. It is due to several factors: the influence of national policies, differences in market accessibility, competitive pressures from larger centers, fragmented trade relations, limited local resources, and economic diversification challenges should be mentioned. The African small towns are vital intermediaries between urban and rural areas, characterized by a mixture of agricultural and non-agricultural activities [24]. They face outmigration and rely heavily on the informal economy due to underdeveloped infrastructure [25]. Many towns function as market hubs for the surrounding rural areas, facilitating the exchange of goods and providing a buffer against climate impacts. However, their economies remain vulnerable to external pressures, including market fluctuations and policy shifts, and they frequently struggle to secure diverse funding sources due to factors such as limited economies of scale, legal constraints, and insufficient management capacity, which tend to channel strategic investments toward larger cities [26,27]. Although several publications

deal with small towns in emerging economies, their economic development, and especially production network integration, is rather a neglected topic.

Emerging from the criticism of GVC/GPN theory, several studies focus on the role of the state and the institutional contexts in shaping coupling processes and influencing the way of production network integration [13,28–30]. States function as (1) facilitators offering favorable local environments for economic development (e.g., investment incentives, infrastructure) or as (2) regulators establishing and enforcing standards and regulations for economic actors (e.g., foreign trade and FDI policy, taxation, labor market regulation). They can function as (3) buyers supporting domestic firms and affecting production network integration through public procurement (e.g., for state administration, educational or health care institutions, military forces) and as (4) producers by owning and operating firms integrated in production networks (e.g., in energy and transport sectors) [31]. However, state policy is a social construction, an outcome of the contests within state institutions and between state and non-state organizations at different spatial scales (Smith 2014), and therefore its importance and components can be different. National states are key players behind rescaling power relations; their delegated rights give weight to global and macro-regional organizations as well as to regional and local governments [32,33]. Attention should be paid to the state's role; beyond the general argument, the character of the case study (a small town in an emerging economy) makes this reasonable.

The case study elaborated in this article is from a country whose culture is a mixture of Mediterranean, Islamic, African, Middle Eastern, and desert influences. Algeria is a hydrocarbon-reliant rentier state with a large public sector (based on the traditions of the French colonial administration and the socialist centrally planned economy) and significant regional inequalities of population distribution and economy due to geographical and historical reasons. Fluctuations in oil prices determine Algeria's fiscal position, investment capacity, and economic growth. On the other hand, regional inequalities are obstacles to socially and environmentally more sustainable development. Thus, the national policy aims at economic diversification by supporting local entrepreneurship and GPN integration [34,35]. The development of non-hydrocarbon sectors producing for both the domestic market and for export is a priority [36]. On the other hand, as a spatial policy aim, a more balanced urban network development should be mentioned. Because small and medium-sized towns constitute about 50% of the urban population in every region of the country, they are important elements of Algeria's Spatial Development Plan (SNAT). Spatial rebalancing also includes economic components that partly focus on small and medium-sized towns, particularly in regions of the Highlands and the southern desert area [37,38]. State-owned enterprises (SOEs) can play a key role in these developments. They are estimated to control around 45% of the country's GDP. Sonatrach, the national oil and gas company, has a central importance within the economy, but state ownership is prominent in the banking sector and in industries like cement, steel, and mining [39].

According to the identified research gap, this paper focuses on the production network integration of a small town in Algeria. Beyond the general problems that characterize small towns as economic locations and the roles national states in production network integration can play, it connects the national policy aims of economic diversification and spatial rebalancing while examining the development and spatial embedding of a state-owned cement factory in a small town of the Algerian Highland East region.

Two questions will be investigated and discussed through the case study:

1. How do multi-scalar (global, national, and local) conditions shape the production network integration of the chosen Algerian small town? What kind of general and specific features can be identified?
2. Which local and national economic, social, and environmental impacts arise from this production network integration? How does it serve the national and local development goals?

The article is structured in the following way: after introduction, materials and methods, two interlinked sections of results (conditions, consequences), discussion, and conclusion are elaborated.

2. Materials and Methods

The research is based on a combined methodology. In the first step, a literature review was carried out to understand industrial production networks, the location characteristics of small towns, and the Algerian context of economic and spatial development. In an earlier empirical study, we examined the spatially uneven development of the Algerian urban network with special attention to the role of small towns [37] when we used the data of the Algerian general censuses of population and housing. Based on the findings, the Highland East region appears to be an optimal location for examining small towns' dynamics playing a role in the development of the rural space beyond the borders of the most urbanized northern coastal regions. In the next step, based on foreign trade data of the International Trade Centre (2003–2022), national economic development documents, press materials, and enterprise web pages, we examined Algeria's participation in the international division of labor, and we chose the cement industry as a case study sector. The narrower location was chosen based on our earlier urban network analysis and the geography of the cement industry when we found that the Highland East has the most cement plants in the highland regions. The case study of the chosen cement factory has been elaborated using secondary information derived from enterprise and municipal web pages, the urban development plan of Sigus (2008), and a thesis about the environmental impacts of the factory. However, primary research based on semi-structured interviews with key persons formed the main basis of the case study (Figure 1).

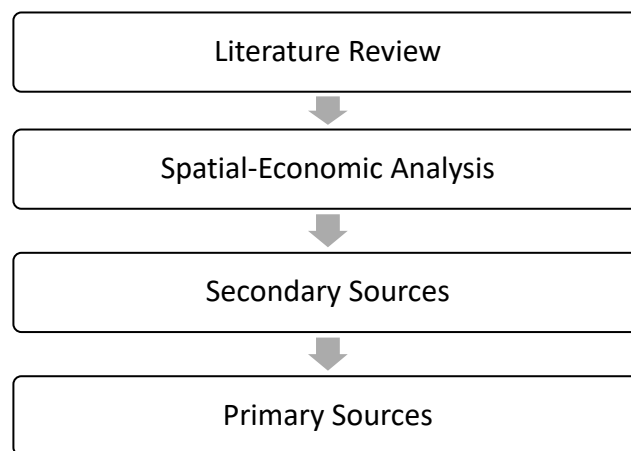


Figure 1. Research methodology. Source: edited by the authors.

The cement industry as a case study has been chosen for several reasons. Algeria primarily integrates into GPNs through the hydrocarbon sector [40,41], but its cement industry has the potential to be an important part of the non-hydrocarbon economy [42]. The sector plays a crucial role in meeting the growing domestic demand for construction materials due to the boom in construction and infrastructure development in recent years [43,44]. It has also enabled Algeria to become a large cement exporter. The cement industry is a growing resource-based sector with locations mostly in small and medium-sized towns, playing a role in the export diversification of Algeria. Yet many studies about the sector in Algeria [45–50] even outside Algeria, like Kusuma et al. [51], Radukić and Perović [52], Ali et al. [53], Branger and Quirion [54], Maradan and Zein [55], and Worrell et al. [56], focus on the environmental side. However, there are no comprehensive case studies on the local development effects of cement factories.

There are also some arguments for examining the cement factory in Sigus. Sigus is one of the 142 small towns in Algeria in 2008 and one of the 29 municipalities in the province

of Oum El Bouaghi in the Highland East region (Figure 2). After the independence, Sigus underwent administrative changes and urban development projects, leading to its growth as a district center within its region. The surroundings have an agro-pastoral economy based on cereal growing and sheep breeding on the collective lands of tribes. Crafts and commerce also play a role, although they are less developed than agriculture [57]. The factory in Sigus is one of the most modern elements of the Algerian cement industry, and as the largest investment of its province, it contributes to the restructuring of the local economy. Elaborating on the case study of the state-owned Sigus cement factory not only gives us insight into the general and Algeria-specific challenges and possibilities of small towns as economic locations but also delivers us sophisticated knowledge about the state's role in shaping production networks. Although all locations have their distinctive features, the specific case study of Sigus gives us insight into the general questions of local economic development in Algerian small towns.

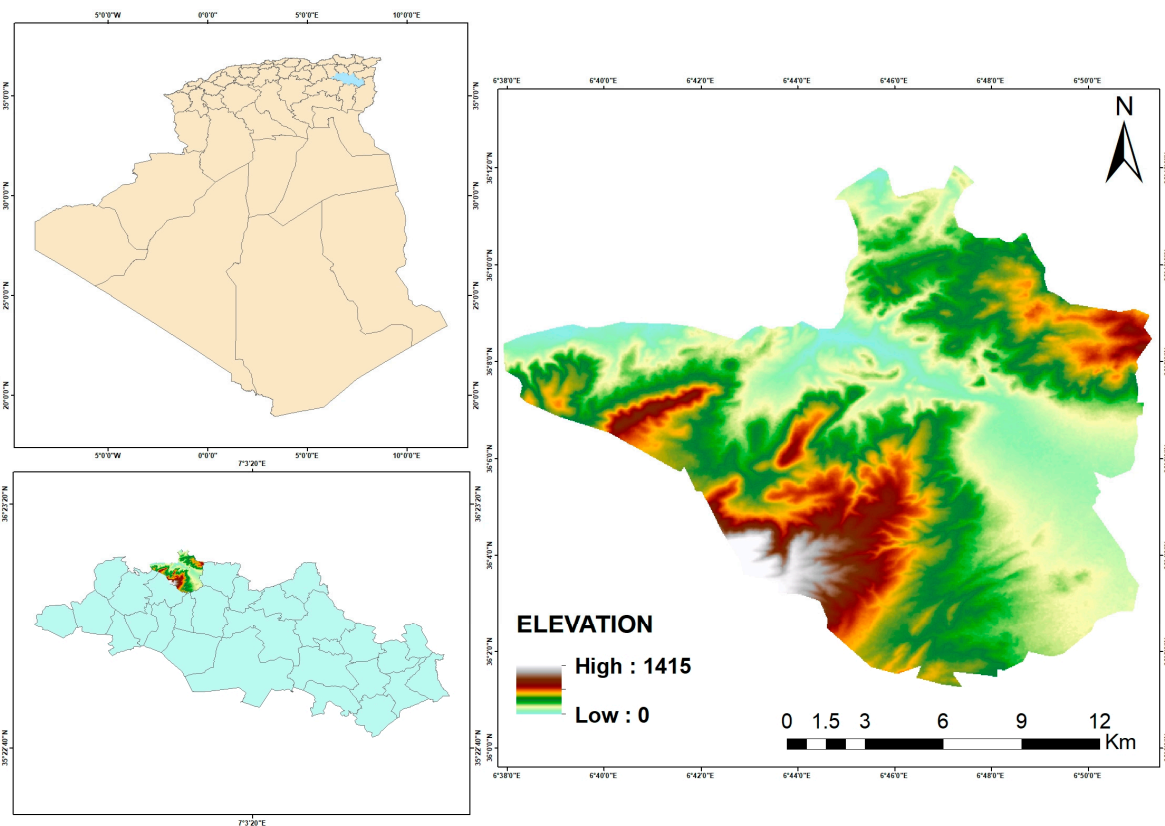


Figure 2. Location of Sigus. Source: edited by the authors.

Sigus had 20,582 inhabitants in 2018. During the period from 1966 to 2018, there was a persistent population increase in its main and secondary agglomerations, juxtaposed with a population decline in the scattered areas (Table 1). This change can be explained by rural–urban migration due to better living conditions and the role of the district center since 1984, which was accompanied by development projects attracting the population. This migration continued during the civil war, considering the city safer than the countryside. However, after 1998, rural–urban migration decreased through rural housing programs and state support for farming. Still, the town has been saturated due to the “housing estates policy”, leading to a scarcity of real estate. As a small town in the Highland East region, Sigus is not a “counterbalancing town” of the SNAT [37], but due to its geographical position, it can contribute to a spatially more even development in Algeria.

Table 1. Population development of Sigus according to the spatial categories of the ONS. Source: census of 1966–1977–1987–1998–2008 and the estimate of the Directorate of Programming and Budget Follow-Up of 2018.

	1966	1977	1987	1998	2008	2018
Main agglomeration	1846	3034	4982	9405	11,750	14,248
Secondary agglomerations	/	/	1361	2168	2756	3333
Scattered areas	10,516	9172	6642	3412	3091	3001
Total	12,362	12,206	12,985	14,985	17,597	20,582

Agglomeration: a grouping of buildings adjacent to each other in a municipal territory, numbering 100 buildings or more, such that no building is more than 200 m away from the other. Main agglomeration: The agglomeration is where the headquarters of the municipality are located. Secondary agglomeration: another grouping in the municipality. Scattered areas: the rest of the municipality comprises small groups of buildings and isolated constructions [58].

The interview participants, both from the side of the firm and local authorities, were selected based on their direct engagement with the factory, ensuring they possessed relevant insights into its establishment and operations (Table 2). We specifically targeted individuals capable of contributing meaningfully to the research while also considering their willingness to participate. The interviews, lasting approximately one hour, were conducted in an open and personal format, facilitating in-depth discussions tailored to each participant's unique experiences and roles within the factory. Each interview was recorded and supplemented with detailed notes. The primary question posed to all participants was to describe their relationship with the factory, encouraging an open dialogue that ensured the information gathered was both specific to each interviewee and consistent in addressing critical aspects of their involvement. Additionally, the interviews were compared with each other and, where relevant, with available statistical data. This triangulation of content enhances the consistency and reliability of the research findings.

Table 2. List of interviewees and their contributions to the case study. Source: edited by the authors.

Position of the Interviewee	Contribution of the Interviewee
Operations manager of Sigus factory	General presentation of the Sigus factory, orders to the workers to help us in collecting the needed info.
Head of the production department of Sigus factory	Production information about the factory.
HR manager of Sigus factory	Employees' information about the factory.
A laboratory engineer at the Sigus factory	Presentation of the products and their quality.
A mechanical engineer at the Sigus factory	Presentation of the production (oven, machines, etc.).
Environmental inspectorate/Directorate of Environment of Oum El Bouaghi province	Presentation of the environmental effects.
Director of the Directorate of Energy and Mines of Oum El Bouaghi province	Presentation of the relation between the factory and the directorate (of energy and mines), and order to the head of the fuel office to give us more information.
Head of the Fuel Office/Directorate of Energy and Mines of Oum El Bouaghi province	Completion of information collected in the factory.
Mayor of Sigous municipality	Presentation of his role in the foundation of the plant.
Directorate of Commerce of Oum El Bouaghi province	Presentation of the relation between the factory and the directorate (of commerce).
Directorate of Industry of Oum El Bouaghi province	Presentation of the relation between the factory and the directorate (of industry).
Head of the Directorate of Civil Protection of Oum El Bouaghi province	Conveyance of the plant's internal intervention plan.
Lawyer of the province of Oum El Bouaghi province	Presentation of how the process of land expropriation and compensation took place through him.

3. Results

3.1. Conditions of Production Network Integration

Cement is an essential material in everyday life. It is widely used in construction and repair, and only a few other materials could claim to be as universal as cement [59]. Cement production has several key steps: (1) First, limestone, clay, gypsum, and other minerals are extracted from quarries. (2) During preparation, materials are crushed and mixed in specific proportions. (3) Calcination covers the heating of the mixture in a kiln (1400–1600 °C) to produce clinker. (4) During cooling, clinker is quickly cooled to stabilize its structure. (5) Grinding means that the cooled clinker is ground with gypsum and other additives to produce cement. (6) At the end, the finished cement is stored in silos and then packaged or shipped in bulk. All these steps of cement production can be vertically integrated within a single factory, or they can be spread across multiple specialized facilities, building up a production network. The first option makes it possible to control the entire production process. However, due to raw materials, energy costs, and transportation, primarily clinker production and cement grinding might be carried out in different locations.

The global cement industry is heavily influenced by large transnational companies. These companies, for example, LafargeHolcim, HeidelbergCement, and Cemex, operate in multiple countries and leverage economies of scale and advanced technologies. Local firms can also play a crucial role in meeting demand for cement within their home countries. These companies are often based on logistical and cost advantages and focus on regional markets. UltraTech Cement in India and Dangote Cement in Nigeria are examples of local companies dominating their national markets but engaging in some export activities. The global cement industry includes state-owned enterprises (SOEs) and private companies. The leading producer is China National Building Material (CNBM), which is an SOE. Other companies like LafargeHolcim, HeidelbergCement, and Cemex are privately owned and publicly traded companies [60,61]. Firms mostly have control over the whole cement production process, from raw material extraction to cement production.

In 2022, with an estimated 2.1 billion tons, over half of all cement produced worldwide was made in China. With a meager 370 million tons, India was the second-largest cement manufacturer [62]. Among the five largest producers, Vietnam (95 million tons), the U.S. (89 million tons), and Turkey (76 million tons) should be mentioned [63]. Due to the high transport costs, the cement industry is primarily oriented toward national markets. However, exports play a significant role in regions with production surpluses. Vietnam and Turkey are global leaders in cement exports, but due to its strong growth, Algeria, our case study country, also took place among the Top 20 cement exporters (Figure 3). Algeria shipped more than 1.5 million tons of cement in the first nine months of 2019, mostly to Mali and Niger [64]. This remarkable upswing suggests successful diversification efforts and increasing competitiveness in the global market for cement-related products. The positive trend aligns with Algeria's strategy to reduce dependence on hydrocarbons and highlights the potential for sustainable growth in this sector [34,65].

Based on the (relative) trade balance compared to the overall volume of exports and imports, the product group including cement, became one of the main specialization fields of Algerian foreign trade (Figure 4). The fluctuations are due to various factors, including the following: (1) Domestic production and surplus: Algeria has significantly increased its cement production capacity, leading to periods of excess supply beyond domestic demand. When this surplus occurs, it naturally results in more exports. (2) Infrastructure projects and economic cycles: Large-scale construction projects or economic slowdowns can affect how much cement is needed locally. When demand falls due to fewer infrastructure developments, more cement is available for export. Conversely, high domestic demand might reduce export levels. (3) Trade policies and global market dynamics: Changes in trade regulations, tariffs, and competition in global markets also influence cement exports. For example, when global demand rises or competitors face production challenges, Algeria's cement becomes more competitive internationally. Additionally, political stability or instability impacts trade agreements and export capacity. (4) Seasonal and climatic

factors: Weather variations affect production and transportation, contributing to cement exports and import fluctuations.

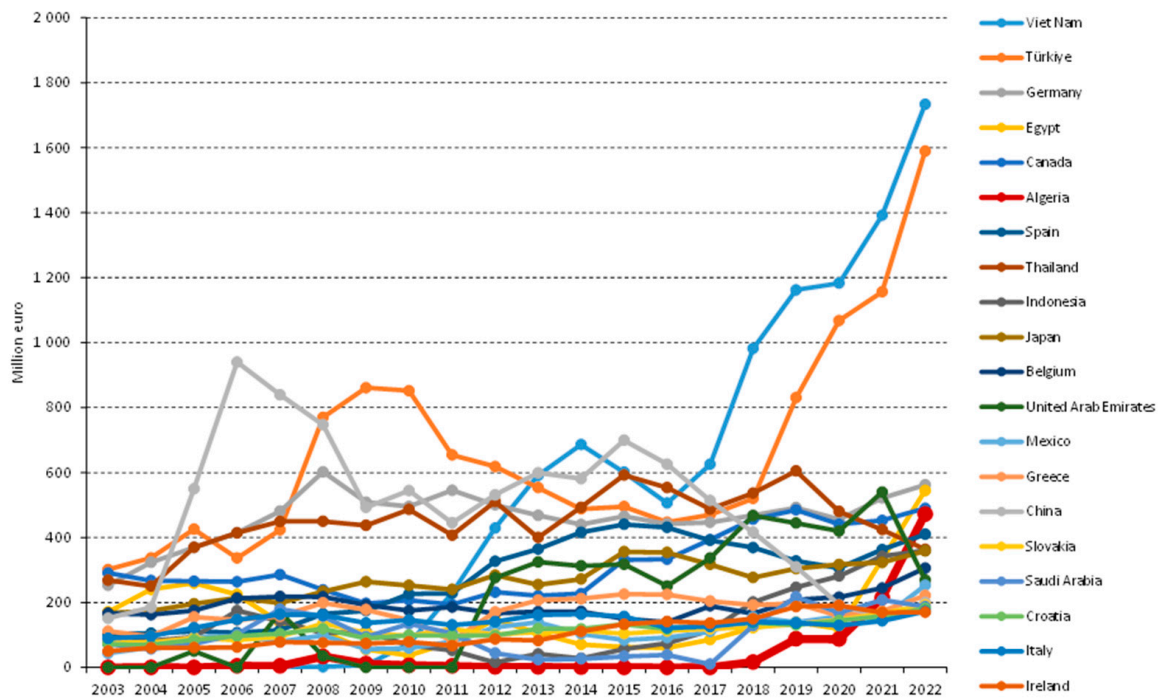


Figure 3. Top 20 cement exporters. Source: edited by the authors based on data from the ITC.

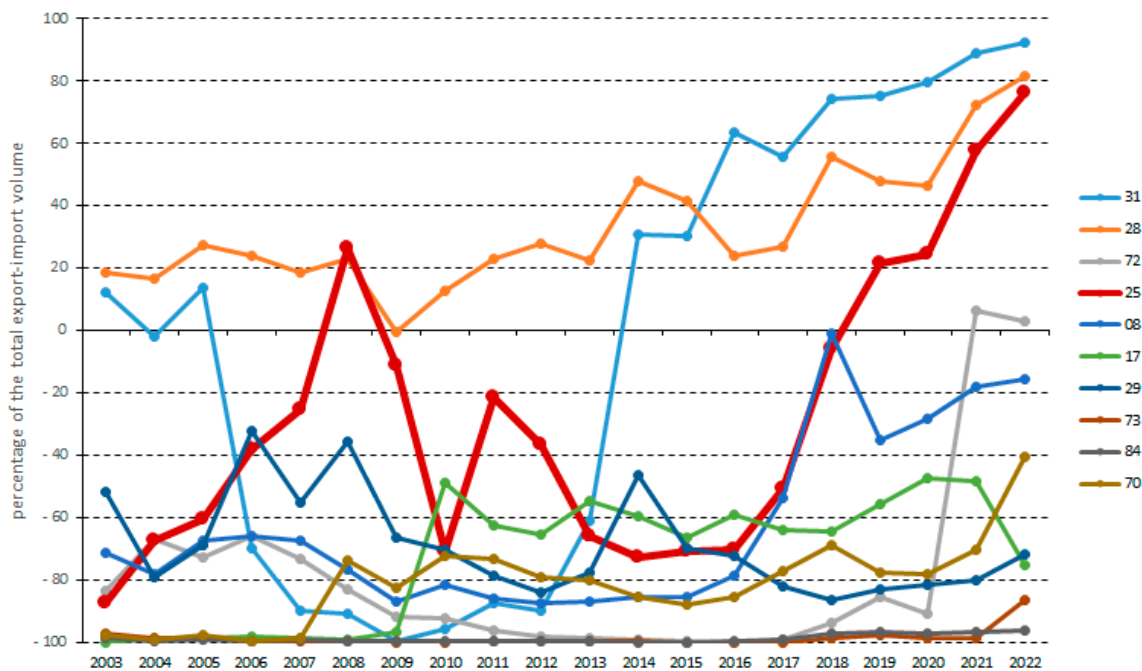


Figure 4. Trade balance of the top 10 non-hydrocarbon products exported by Algeria, in percentage of the total export–import volume. Source: edited by the authors based on data from the ITC. 1, fertilizers; 28, inorganic chemicals and organic or inorganic compounds of precious metals or rare-earth metals; 72, iron and steel; 25, salt, sulfur, earth and stone, plastering materials, lime, and cement; 08, edible fruit and nuts, peel of citrus fruit or melons; 17, sugars and sugar confectionery; 29, organic chemicals; 73, articles of iron or steel; 84, nuclear reactors, boilers, machinery, and mechanical appliances, and parts thereof; 70, glass and glassware.

Algeria seeks to create a more balanced and sustainable economic landscape by supporting industries like cement manufacturing. However, it is important to note that the cement industry is not the primary driver of economic diversification. Algeria has been exploring various sectors, including agriculture, manufacturing, and renewable energy, to achieve a more diversified and resilient economy [36]. However, only a part of these sectors is spectacularly represented in the export structure of the country: several activities (e.g., agri-food and textiles) are developed to supply primarily the domestic market [66].

As of 2022, Algeria boasts a thriving cement sector, with seventeen operating cement production facilities (Table 3). These plants can produce an impressive annual output exceeding 23 million tons directed to the domestic market or exported according to market needs/possibilities employing the efficient dry technique in almost every cement factory. One noteworthy aspect of this sector is its substantial reliance on natural gas as the primary source of energy for the majority of these manufacturing enterprises. Thus, considering the hydrocarbon reserves of Algeria, the development of the cement industry is not only useful but also a logical step of national economic policy targeting diversification. The cement production landscape in Algeria is marked by its location in the small towns and smallest urban settlements and the involvement of three distinct types of enterprises.

Table 3. Cement plants in Algeria. Source: collected by the authors based on factory web pages.

Cement Plants	Type of Town (in 2008)	Company Name	Start of Production	Production (Tones/Year)
Meftah (Blida)	small town	GICA	1901	800,000
Rais Hamidou (Algires)	small town	GICA	1914	300,000
Zahana (Mascara)	smallest urban settlement	GICA	1948	800,000
Hadjar Soud (Skikda)	smallest urban settlement	GICA	1973	900,000
El Hassasna (Saida)	smallest urban settlement	GICA	1978	400,000
Oued Sly (Chelef)	smallest urban settlement	GICA	1978	1,200,000
Ain el Kebira (Sétif)	small town	GICA	1978	3,000,000
Beni Saf (Ain timechent)	small town	GICA	1979	800,000
Hamma Bouziane (Constantine)	medium-sized town	GICA	1982	700,000
Sour-el-ghozlane (Bouira)	small town	GICA	1983	1,000,000
Ain Touta (Batna)	medium-sized town	GICA	1987	1,000,000
El Ma Labiod (Tebessa)	smallest urban settlement	GICA	1995	500,000
Hammam Dhalaa (M'sila)	small town	Lafarge	2004	4,000,000
Oggaz (Mascara)	smallest urban settlement	Lafarge	2008	3,500,000
Branis (Biskra)	smallest urban settlement	Société Biskria Ciment (S.B.C).	2009	2,700,000
Sigus (Oum el Bouaghi)	smallest urban settlement	GICA	2019	2,000,000
Bechar	large city	GICA	2020	1,000,000

Large city: urban concentration with a population of at least 100,000 inhabitants; medium-sized town: urban concentration between 50,000 and 100,000 inhabitants; small town: urban concentration between 20,000 and 50,000 inhabitants; smallest urban settlement: urban concentration between 5000 and 20,000 inhabitants.

Firstly, state-owned enterprises are represented by the Industrial Group of Algerian Cements (GICA). The evolution of Société Nationale des Matériaux de Construction (SNMC) into Groupe Industriel des Ciments d'Algérie (GICA) marks a significant transformation in Algeria's construction materials sector. Initially established in 1967, SNMC managed small production units but expanded its operations to meet the rising demand by constructing new plants across the country. In 2009, SNMC was restructured into GICA, a joint stock company owned by the Algerian state. GICA diversified its activities in various segments like cement, aggregates, and ready-mixed concrete production, including distribution, maintenance, training, and technical assistance. GICA has also expanded internationally, tapping into different markets across Africa, Europe, and Latin America, demonstrating its role in shaping Algeria's construction materials sector into a dynamic and diversified industrial group [67]. Secondly, international private players like Lafarge, in collaboration with local partners, contribute to Algeria's cement production capacity. This partnership reflects the global footprint of multinational corporations working with local expertise and creating a dynamic and competitive landscape. The first export of gray cement began in December 2017; it has increased over the years and includes all products [cement, clinker, and mortars] and all packaging combined [bulk and bag/gris and blanc], transported to African and Mediterranean markets [68]. Thirdly, a few local companies in cement production should be mentioned.

There were several reasons for choosing Sigus and its southeastern edge as the location of a cement plant. The following points should be mentioned: (1) The closed ports in Skikda provide accessibility to the external markets. (2) There is a proximity to a standard gauge railway network linking east and west and a narrow gauge line linking Constantine and Algiers. (3) A relatively developed road network ensures the easy transport of people and goods. (4) There are raw material (especially limestone) deposits close to the factory in the required quality and quantity. (5) The natural difference in altitude between the limestone deposit and the factory allows easy transport of this raw material. (6) Accessibility of public utilities offers the possibility to operate the plant. (7) The area is neither classified as an archaeological/historical site nor is agricultural land; because of the clayey/conglomeratic soil, no vegetation can take hold there. (8) There are no fauna nor flora of ecological interest here. (9) From a geotechnical point of view, the factory could be built.

There were several actors who played a role in the investment. The establishment of the Sigus cement factory was managed by the state-owned enterprise of GICA and came under Legislative Decree No. 13/390 of 24 November 2013, within the framework of the policy of reviving industry and promoting investment in Algeria. It was a decision of the Algerian government. At the national level, various ministries, including those responsible for energy and mines, commerce, environment, and industry, were involved in signing decrees and authorizations for the construction and operation of the factory. Locally (at the level of the province), the Directorate of Environment assesses the environmental impact of the factory. The Directorate of Energy and Mines, representing the appropriate ministry, participated in the site selection committee considering security easements for electricity and gas networks, grants licenses for acquiring sensitive materials and hazardous chemicals, and oversees the exploitation of quarries. The Directorate of Industry requests the creation of an internal intervention plan (P. I. I.). This plan is applied in industrial establishments in the event of fire, explosion, or release of toxic substances, which can create risks for workers, property, the population, and the environment. The plan was elaborated by a studies office in coordination and consultation with the Directorate of Civil Protection. A copy was sent to the departments responsible, including the Directorate of Energy and Mines, to approve it. The Directorate of Commerce manages market control and financing aspects. The governor controlled the expropriation process, confiscated the property (based on the proposal of the Director of Organization and Public Affairs), and compensated the landowners based on Executive Decree No. 13-390 of 24 November 2013. The municipality's mayor played a minimal role, which focused on determining the land for the factory. Thus, local authorities were involved in land allocation, expropriation, and compensation

processes. This comprehensive, multi-tiered involvement underscores the centralized character of regional economic development and the complexity and bureaucratic coordination necessary for industrial projects in Algeria.

3.2. Consequences of Production Network Integration

In the Sigus cement factory, there are three important steps of cement manufacturing: preparation of the raw material, production of clinker, and production of cement. The factory uses the best available technologies provided by France. Based on more efficient energy consumption, they meet the most demanding environmental and safety standards (dust emissions $< 10 \text{ mg/Nm}^3$, GAS consumption: 730 kcal/Kg of clinker, power consumption: 89 kWh/ton of cement, $\text{CO} \leq 150 \text{ mg/Nm}^3$, wastewater treatment for a capacity of 700 people). The installed capacity is 2 million tons per year. The firm started clinker production in September 2019, which has grown over the years (Figure 5).

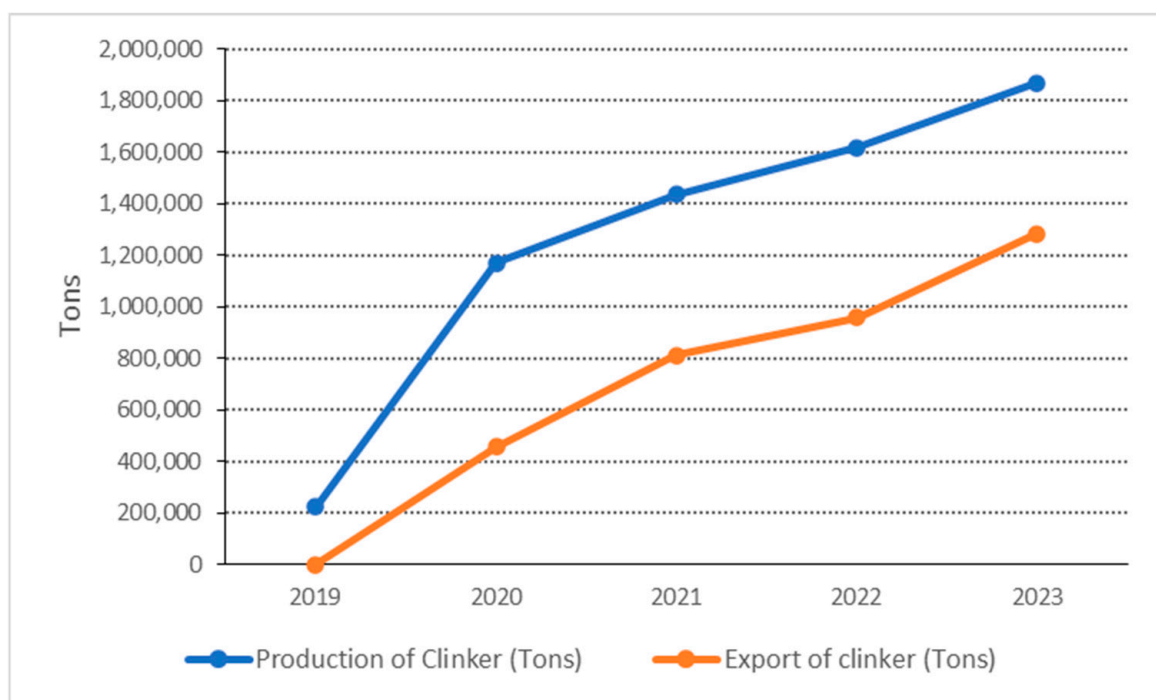


Figure 5. Production of clinker in the Sigus cement factory. Source: based on the interviews. Clinker is the raw material of cement. It is a nodular material produced by heating a mixture of limestone and clay to high temperatures in a cement kiln. The mixture is then ground into a fine powder to make cement.

As we reconstructed from the interviews, the factory has multi-scalar spatial embeddedness (Figure 6). On the input side, the primary raw materials are local: limestone is from the Fortass Mountain (Sigus), and clay is from Koudiat Birou (Sigus). Secondary raw materials come from the broader region: the sand is from Bhiret Chergui (23 km from Sigus), and the iron ore is from Ouenza (164 km from Sigus). Corrective additions like tuff, pozzolan, slag, and gypsum come from the neighboring provinces. The factory organizes the transport of limestone from the quarry to the factory itself. Other raw materials are transported by different private suppliers. Electricity and gas supply is organized by national companies (Sonelgaz).

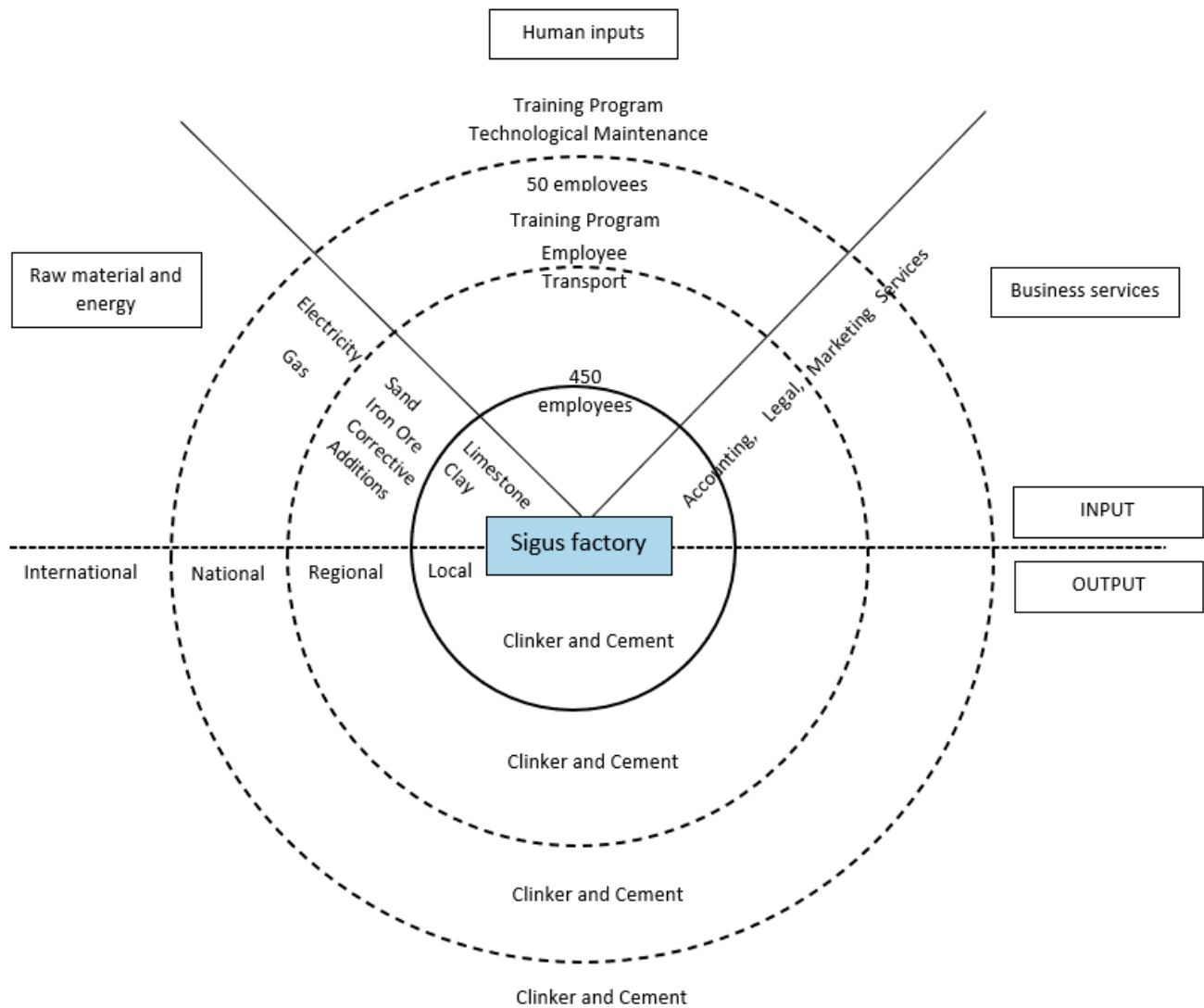


Figure 6. Spatial relations of Sigus cement factory. Source: edited by the authors. “Local” means the municipality of Sigus and the province of Oum El Bouaghi, “regional” covers the neighboring provinces, “national” means the level of the country, and “international” includes relations outside Algeria.

The factory has 500 employees, including 20 senior executives, 120 management executives, 155 engineers and technicians, 170 masters, and 35 executives. They are mostly from the region: 90% are inhabitants of Sigus and the surrounding towns in the province of Oum El Bouaghi, while 10% are from other provinces (e.g., Tebessa, Constantine, Skikda). In order to support commuting, a fleet of buses operates along three primary routes: Oum El Bouaghi to Sigus, Ain Melilla to Sigus, and Constantine to Sigus. To ensure the skilled labor force, a comprehensive employees’ training program was organized at the capital city’s Cement Industry Training Centre. It lasted six months to one year, depending on the field of expertise. Because of French technology used in the factory, some training in France was also required. These educational programs represent inputs on a national level, similar to business services provided not by local and regional partners.

On the output side, clinker's delivery to local, regional, and national markets and its export to Ghana, the Ivory Coast, Mauritania, and Senegal, which started in 2020, should be mentioned. The factory also produces cement, but only in a relatively small quantity compared to the clinker. It means that the company primarily specializes in intermediate products, which gives the basis for cement production in other locations. In this way, the factory is a part of several national and cross-border production networks. Cement exports began in August 2024 to Germany after the factory received the appropriate license from the responsible ministries in March 2024. The connection with the German market reaches far beyond the region and represents the extra-regional dimension of linkages.

The factory is the largest investment in the local economy both in the municipality of Sigus and the province of Oum El Bouaghi. Accordingly, it has economic, social, and environmental effects on multiple spatial levels. These effects can be positive or negative and can appear on local and national levels in different ways (Table 4).

Table 4. Effects of the cement factory. Source: edited by the authors.

Effects		Positive	Negative
Economic aspect	Local level	<ul style="list-style-type: none"> - Met the local/regional demand for cement. - Direct and indirect job creation. - Development of infrastructure. - Development of local transport. - Income multiplier effects generating plus growth in other sectors (e.g., services). 	<ul style="list-style-type: none"> - A decline in real estate prices near the plant. - The influx of more efficient businesses can increase competition, which may put pressure on local businesses, which may face reduced profits.
	National level	<ul style="list-style-type: none"> - Contribution to self-sufficiency in cement. - Contribution to hard currency export revenues and advantageous trade balance. - Contribution to the growth and economic diversification of the national economy. - Due to taxes paid by the factory additional incomes for the state budget. 	
Social aspect	Local level	<ul style="list-style-type: none"> - Reduction in unemployment. - Wages around the local (municipal) average depending on the position within the factory. - Investing in workforce training programs enhances the skills of the local workforce. - A standard specification related to the occupational health and safety system. 	<ul style="list-style-type: none"> - It could lead to social displacement and cultural erosion. - Imbalanced growth of urban agglomerations in Sigus municipality.
	National level	<ul style="list-style-type: none"> - Using the revenues of the factory to cover the deficit of housing or public facilities. 	
Environmental aspect	Local level	<ul style="list-style-type: none"> - Increased value of primary resources. - Adopting modern (environmentally more sustainable) technology in production. 	<ul style="list-style-type: none"> - During the construction and operation: air pollution and noise pollution.
	National level	<ul style="list-style-type: none"> - Increased value of primary resources. - Adopting modern (environmentally more sustainable) technology in production. 	<ul style="list-style-type: none"> - Potential air pollution caused by the factory in case of no changing the filter.

The factory meets the demand for cement in the provinces of Oum El-Bouaghi, Khenchela, and Constantine and provides jobs primarily for the residents of the narrower area. Indirect employment opportunities include jobs in transportation services, housing markets, equipment sales and maintenance, and contracts with construction companies and machinery manufacturers. The factory also stimulates the local economy by increasing workers' spending in nearby businesses, particularly those along National Road N10. The state has undertaken infrastructure enhancements to support the factory's operations. It developed National Road N10 into a divided highway. This development aimed to facilitate the efficient transportation of goods and materials to and from the factory. Furthermore, the state provides the necessary utilities, such as gas and electricity, with a capacity of 6,000,767.76 Nm³ and 106,028 KW per day to cover the factory's operational needs. These measures reflect the government's commitment to promoting industrial growth and supporting the factory's contribution to the local economy. The Sigus factory is also exempt from IBS and TAP for its first ten years as another point of support from the state. While legal entities in Algeria, including businesses, are subject to various taxes, like VAT at 19% and corporate income tax (IBS) at 26%, which fund public expenditures and services. The professional activity tax (TAP) was set at 2% for local development but was abolished in 2024 [69]. However, the factory must pay an annual environmental tax of 810,000 DA. Additionally, the factory contributes to the social well-being of its workers by providing health care and compensation, thereby improving their overall living conditions.

On the other hand, the factory could lead to social displacement and cultural erosion by forcing residents to move or disrupting their way of life. Land use or economic changes, such as shifts in job availability or rising costs, may make it difficult for people to remain in the area. As Sigus has traditionally been an agricultural community, the rise of industrial activities may weaken its farming-based cultural identity, replacing traditional customs and social relationships with industrial values and practices. The factory also negatively affects air and soil quality and biodiversity due to dust and gases resulting from the various stages of production (blasting, mining, transportation, crushing, grinding, burning, cooling, and packaging). Despite the factories using modern technologies, these may affect the agricultural productivity of the town's agricultural lands and human health as well.

4. Discussion

Although the factory belongs to a state-owned company whose network is rather national than global, its location choice in Sigus can be interpreted as a strategic coupling process between the cement production networks and the local economy [1,15]. Multi-scalar regional conditions play a key role in the network integration of the case study town, whereby local/regional, national, and even international factors have been identified. However, local factors play only a limited role in shaping this production network integration. It can be explained by the complex role the Algerian state played in this development project, strengthened by its centralized character, and by the shortcomings of small towns' local environment, which should be counterbalanced with inputs from other places. While the first point is a specific factor, shortcomings of the small town's environment can be evaluated rather as a general factor globally characterizing this group of settlements.

In line with the findings of Horner [31] and Smith [70], the national state plays a complex role in shaping production network integration, i.e., strategic coupling between the cement industry and the small town. At first, it is a facilitator supporting the establishment and operation of the cement factory by providing tax exemptions for the factory and building up the necessary infrastructure to ensure the raw materials and fuels for its production. Secondly, the national state acts as a regulator, determining the legal framework within which the cement factory operates. This includes general market and tax regulations, labor laws and safety standards, and environmental regulations that the factory must comply with. The state's role in ensuring that the factory adheres to these regulations is crucial for balancing economic development with social and environmental responsibilities. Thirdly, the state also functions as a consumer. It offers a market for the factory by purchasing

cement for public infrastructure projects, including a dam, bridge, and road tunnel projects under the supervision of Cosidar Group (an Algerian public construction and public works group). By prioritizing local production through public procurement, the state supports the cement factory in Sigus, promoting local economic growth and production network integration. Last, but not least, the state is also a producer in this case study. The state-owned nature of the Sigus cement factory (GICA company) reflects the government's commitment to maintain control over the critical industries and to ensure that they contribute to the national economic goals. This involvement can lead to more stable investment in local economies compared to private companies, which may prioritize short-term profits. The case of the Algerian cement factory is also seen in other countries with centralized governance, like China. In this nation, SOEs are frequently used to achieve broader national economic goals in critical industries like cement, steel, and energy [71]. Additionally, this focus on national development over immediate profitability aligns with strategies observed in many emerging economies. For example, in Brazil's oil industry and China's cement sector, state ownership aims to fulfill long-term goals such as infrastructure development, employment, and national self-sufficiency, often at the expense of short-term financial gains [72]. This approach underscores SOEs' broader developmental roles in emerging economies, linking economic modernization to strategic national objectives.

The complex role of the national state is strengthened by the centralized character of the Algerian state. At the level of the provinces (48 spatial units), there are directorates representing the various ministries and governors appointed by presidential decree who are the real mediators of the government and have the real leadership of the province. They play a key role in shaping the local assets but are parts of the top-down, deconcentrated structure of the Algerian central institutions. The governor has control powers of both administrative and judicial types. He/she oversees civil protection, organizes first aid, maintains public order, respects judicial independence, and responds to natural disasters and accidents. This means that the governor holds more significant power, particularly in strategic decisions, than the elected mayor of the municipality (1541 spatial units). The mayor's role is also dual: a representative of the state at the municipal level and a representative of the municipality's interests toward the province. However, it is more administrative and localized and has no authority to reject the decision that came from the top. This centralized structure is similar to some earlier case studies from Hungary where, due to a re-centralization process, local governments could play a moderate role in local economic development [29,33]. Despite the different historical and cultural contexts, the effects of French administrative traditions may be assumed in both cases.

Limitations of small towns also play a key role in the importance of multi-scalar assets and institutions. Sigus benefits from local assets like raw materials, a capable workforce, and transport connections that support its production network integration but also struggles with some shortcomings that characterize small towns. Limited population, which restricts the labor pool and skill diversity; resource constraints that hinder the necessary investments in infrastructure and workforce development; and a not-too-diverse economic base, making the town vulnerable to sector-specific downturns, should be mentioned. To ensure sustainable growth, overcoming these challenges requires a collaborative approach involving local governance, community engagement, and partnerships with higher authorities and external organizations. Cement production network integration can be regarded as a "pipe" for the locality that helps to channel in external knowledge and contributes to overcoming the limitations of the local economic environment [19]. GICA and Cement Industry Training Centre contribute to local economic restructuring and development by channeling external knowledge due to the new factory and training the workforce with up-to-date industry-specific skills.

The consequences of strategic coupling between cement production networks and the local economy are largely determined by the state-owned and domestic character of the investing company. According to the literature, SOEs often prioritize national or regional development goals over immediate profitability, investing in strategically

important areas for economic diversification and social welfare, even if returns are not immediate. SOEs tend to comply more stringently with national regulations and standards, emphasizing social and environmental responsibilities. In contrast, private companies focus on maximizing shareholder value, often selecting locations with higher profit potential and may seek to minimize compliance costs, resulting in varying adherence to standards [73,74]. The case of the Sigus cement factory exemplifies the more fruitful first option of strategic coupling. Despite its relatively recent establishment, the factory has achieved strong profitability while adhering to state development goals. The state-owned character of the factory ensures a long-term commitment to the region, fostering stable economic growth rather than the short-term exploitation of local resources. Training the workforce, higher salaries, and working conditions that meet strict standards may contribute to a social upgrading process [7], completing the project's economic success. This aligns with the literature's argument that SOEs can generate higher value added and capture and a more stable local presence than private enterprises. Despite the absence of real hard-to-reproduce quality local assets, this argumentation shows a rather fruitful strategic coupling instead of temporary exploitation of the available local assets [5,15].

This strategic coupling between the state-owned enterprise and Sigus's economy has significant consequences. At a national level, the factory influences sectoral and spatial growth, aligning with Algeria's economic diversification and spatial rebalancing goals [34,65]. It boosts GDP, employment, and state revenues, contributing to a more balanced budget. Additionally, the factory enhances Algeria's self-sufficiency in cement production, reducing import reliance and strengthening the trade balance through increased export revenues. The taxes generated further support national development. Environmentally, the factory adds value to primary resources by adopting sustainable production technologies. However, potential air pollution risks underscore the need for continued investment in environmental safeguards to ensure sustainable development, aligning with the studies of Guettouche et al. [45], Shahri [46], Bahmed et al. [47], Boughrara et al. [48], and Kaabèche-Djerafi et al. [49].

Locally, the factory stimulates economic growth by creating jobs, improving infrastructure, and enhancing workforce skills. The Sigus Master Plan for Development and Urbanism (PDAU, 2006) emphasized agricultural development, infrastructure improvements, and industrial growth by creating an industrial zone along National Road N10 to boost the local economy while preserving the environment. The development plan of the provinces of Oum El Bouaghi (PAW, 2006) also emphasized the importance of the industrial zone. However, establishing the Sigus cement factory was not part of this local plan, indicating that it was a decision made at a higher level. Regionally, it promotes economic integration, balanced development, and sustainable use of local resources, contributing to regional economic stability. While the factory brings significant local benefits, it also poses challenges, such as a drop in property prices near the plant, unbalanced urban growth within the Sigus municipality, and possible threats of social displacement and the erosion of local culture. Moreover, a study conducted in August 2020 [75] involving 30 residents living near the factory revealed widespread opposition to its establishment. The residents expressed concerns over potential environmental and health impacts, citing the lack of consultation before the factory's construction.

The decision to establish the factory was made centrally without considering the community's opinions. It should be emphasized that the economic development realized in Sigus can be classified as a national (and not local) industrial development project based on external resources dominated by state financing. It means a large-scale, top-down industrial development project also including its infrastructural background but realized without the local community. It shows the specificities of the "traditional way" of regional economic development typical in Europe after the WWII era [76]. Table 5 summarizes the responses to the research questions, encapsulating the essential findings and insights derived from the study.

Table 5. The main results of the research. Source: edited by the authors.

Questions	Answers
How do multi-scalar (global, national, and local) conditions shape the production network integration of the chosen Algerian small town? What kind of general and specific features can be identified?	<ul style="list-style-type: none"> - Multi-scalar factors: Local/regional, national, and international factors are crucial for production network integration. - General shortcomings in the local environment (e.g., limited human resources) typical for small towns are counterbalanced by inputs from other (regional, national, international) places. - Specific predominance of national factors: The Algerian state plays a complex and central role due to its centralized nature and the involvement of the state-owned enterprise.
Which local and national economic, social, and environmental impacts arise from this production network integration? How does it serve the national and local development goals?	<ul style="list-style-type: none"> - Economic impacts: The factory drives economic restructuring and growth and creates direct and indirect jobs both on local and national levels, but may increase local competition, disadvan-taging local businesses and generating a crowding-out effect. - Social impacts: The factory contributes to a lower unemployment rate, better working conditions, and improved local and national skills and qualifications, but it can generate social displacement and cultural erosion in the local context. - Environmental impacts: Through adopting international technological standards, the factory promotes sustainable practices both on local and national levels, but it can contribute to the degradation of the local environment if regulations are insufficient. - Connection with national development goals: The factory supports national objectives of economic diversification (growth of non-hydrocarbon sectors) and spatial rebalancing (in a region beyond the overcrowded Mediterranean coastline). - Connection with local development goals: The impacts of the factory are primarily contradictory on the local level. It requires a careful evaluation to maximize benefits and mitigate negative outcomes, as well as calls for the involvement of the local community.

5. Conclusions

This paper examines the conditions and consequences of production network integration in small towns, focusing on empirical research in Algeria, an emerging hydrocarbon-reliant rentier economy characterized by significant regional inequalities and political efforts toward economic diversification and spatial rebalancing. The case study of a state-owned cement factory in the small town of Sigus provides valuable insights into the state's role in shaping production network integration and the unique characteristics of small towns as locations within the modern economy. The research methodology includes secondary data and information and semi-structured interviews. The results highlight the importance of a multi-scalar regional framework in integrating into production networks and identifying local, regional, national, and even international factors. However, national factors dominate, mainly due to the Algerian state's centralized control and the limited capacity of the small town's local environment, which external inputs must supplement. This integration aligns with national policy goals of economic diversification and spatial rebalancing but presents contradictory impacts at the local level. Economically, while production network integration drives growth and creates employment, it may also increase competition, disadvantaging local businesses. Socially, it enhances local skills and job opportunities but poses risks of social displacement and cultural erosion. Adopting international standards can promote sustainable practices, but insufficient national and local regulations may lead to environmental degradation. These contradictions underscore the need for careful, critical evaluations to ensure that the benefits of production network integration are maximized while minimizing its negative consequences. It calls for more consistent involvement of the local community in similar economic development decisions. Nevertheless, this research has certain limitations, mainly focusing on the Sigus case study. While the case provides valuable insights, it may not fully reflect the diversity of opportunities and challenges that small towns typically encounter, including their unique local characteristics and specific contexts. To gain a more comprehensive understanding, further research is necessary to explore the integration of Algerian small towns into global, regional, and national production networks across various sectors.

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