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Industrial Policy-Making Using Big Data from the Product Space and Network Science

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A B S T R A C T

The global trend of data production and expansion, along with the development of new methods for analyzing big data, has led to the practical application of these methods across various domains, including industrial policy-making. Most existing studies in the field of industrial policy-making have adopted qualitative approaches, with only a few employing quantitative methods. This study applies an economic complexity approach and the product space framework, utilizing big data from 235 countries in the year 2023 based on 1,224 four-digit product codes from the Harmonized System (HS), to design industrial policy for the Republic of Iraq. The findings reveal that Iraq has exhibited revealed comparative advantage (RCA) in the production and export of 15 products, which are primarily raw materials and primary commodities such as oil, minerals, and agricultural goods. By applying network science and the product space model developed by Alshamsi et al., it was also determined that there is potential for Iraq to develop a revealed comparative advantage in 88 additional products. Considering the criteria of positive opportunity gain, product complexity index, and proximity, a total of 11 products were ultimately identified and introduced as emerging opportunities for Iraq.

Keywords: *big data, network science, product space, economic complexity*

1. Introduction

In the ever-evolving landscape of global economic development, the strategic diversification of national production and export portfolios has emerged as a crucial pathway for sustainable growth and resilience, particularly for resource-dependent economies such as Iraq. In recent decades, economic complexity theory and product space analysis have provided powerful tools for understanding and guiding such diversification processes. These frameworks facilitate the identification of viable new industries by analyzing patterns of relatedness between products, mapping potential development trajectories, and assessing their compatibility with a country's existing capabilities (Alshamsi et al., 2018; Hartmann et al., 2020). Iraq's heavy reliance on oil exports, which accounted for over 90% of total export revenues in recent years, underscores the urgency of this diversification imperative (Mayer et al., 2023; Ola Alii & Falah khalaf, 2022).

The theory of economic complexity posits that the diversity and ubiquity of a country's export basket can reveal the embedded productive knowledge and institutional capacity of its economy. By analyzing trade data and constructing the Economic Complexity Index (ECI), researchers can quantify a country's latent capabilities and its potential for future growth (Dadgar & Fahimi, 2024; Javaheri et al., 2024). This approach has been effectively applied in several national contexts, demonstrating its predictive power for long-term income growth, structural transformation, and innovation (AlOtaibi & Sallam, 2025; Tran & Freytag, 2025). For Iraq, such an analysis is particularly relevant given the country's geopolitical volatility, underutilized industrial capacity, and growing need for inclusive economic development (Blazquez & Domenech, 2018; Sagheb et al., 2023).

One of the primary strengths of economic complexity analysis lies in its ability to integrate network theory and trade data to model the product space—a network where nodes represent products and links indicate the proximity or similarity in the capabilities required to produce them. The structure of this space can reveal development traps, clusters of opportunity, and realistic trajectories for product diversification (Pinheiro, 2025; Syrquin & Chenery, 1989). In the context of Iraq, this approach allows for identifying export products that are closely related to existing specializations and thus more likely to be competitively developed in the short to medium term (Alshamsi et al., 2018; Sezai, 2020).

Recent empirical applications of product space methodologies to Middle Eastern economies, including Iran and Saudi Arabia, have yielded important insights. For example, studies have shown that while both countries possess high export concentration, their diversification paths differ due to varying levels of economic complexity, institutional quality, and innovation systems (AlOtaibi & Sallam, 2025; Simaee et al., 2021). Similar studies on Iran have demonstrated how targeting related products—those sharing similar technological and institutional requirements—can mitigate the risks of policy misalignment and industrial stagnation (Dadgar & Fahimi, 2024; Khosravi et al., 2020). These findings support the strategic use of relatedness as a core principle in industrial policy planning, especially in rentier states with narrow productive bases.

In Iraq's case, the structure of the product space reveals a high dependence on low-complexity products such as crude oil, refined petroleum, and a handful of mineral and agricultural goods. The average Product Complexity Index (PCI) of Iraq's top exports remains in the negative range, reflecting a weak foundation for value-added production and technological upgrading (Ahmadian Divkoti et al., 2019; Mayer et al., 2023). However, product space analysis indicates that Iraq is not devoid of diversification opportunities. By examining products at the "capability frontier," i.e., those with high proximity to Iraq's current exports and higher complexity, policy-makers can identify sectors that offer both feasibility and growth potential (Ola Alii & Falah khalaf, 2022; Zobeiri, 2025).

Moreover, network-based models such as the one proposed by Alshamsi et al. (2018) enable the estimation of the activation probability of a product—that is, the likelihood that a country can develop comparative advantage in a given product based on its existing capabilities and the structure of the product space. This model incorporates critical dimensions such as proximity, opportunity gain, and economic complexity to create a data-driven, evidence-based industrial policy framework (Alshamsi et al., 2018). When applied to Iraq, this model reveals that although the country currently has revealed comparative advantage in only 15 out of 1,224 HS-4 product categories, it has potential for activation in 88 additional products, many of which are more complex and capable of enhancing Iraq's ECI if developed strategically (Javaheri et al., 2024; Pinheiro, 2025).

The significance of big data analytics in these analyses cannot be overstated. The use of large-scale trade datasets, drawn from global platforms such as the Harvard Atlas of Economic Complexity, allows researchers to construct granular country–product matrices and compute sophisticated indicators like RCA, PCI, and ECI. These computations form the backbone of contemporary product space mapping and diversification modeling (Blazquez & Domenech, 2018; Tran & Freytag, 2025). Moreover, combining these data with geoeconomic factors and institutional diagnostics enhances the precision and contextual relevance of policy recommendations (Hartmann et al., 2020; Syrquin & Chenery, 1989).

Importantly, the identification of high-OPG (Opportunity Gain) products is central to effective prioritization in industrial strategy. OPG quantifies the potential improvement in a country's ECI if it were to develop RCA in a given product. Products with high OPG, low distance (i.e., high proximity), and above-average complexity represent "low-hanging fruit" for policy focus (Khosravi et al., 2020; Sagheb et al., 2023). For Iraq, these products lie largely within the mid-range of the complexity spectrum—

such as bituminous derivatives, metal products, and certain industrial chemicals—which are technologically adjacent to the country's existing capabilities but offer much higher value-addition and market diversification potential (Pinheiro, 2025; Simaee et al., 2021).

Another noteworthy consideration is the interaction between economic complexity and non-economic variables such as governance quality, gender equity, and institutional capacity. Studies have underscored that economic complexity not only reflects productive knowledge but also correlates strongly with broader socio-political development indicators, including human capital, innovation capacity, and institutional inclusiveness (Azadeh Mansoreh, 2005; Breen et al., 2017; Zobeiri, 2025). For instance, countries with more democratic governance structures and gender-balanced policies tend to have more diverse and complex economies—pointing to the need for an integrated, cross-sectoral approach to industrial transformation.

Despite the promise of economic complexity as a policy tool, its application is not without limitations. As several scholars have noted, the methodology is highly sensitive to data quality, and its predictive accuracy diminishes in highly volatile political environments where institutional discontinuity disrupts capability accumulation (Pinheiro, 2025; Tran & Freytag, 2025). Moreover, structural constraints such as energy dependency, regional instability, and limited R&D infrastructure may hinder Iraq's ability to fully realize its complexity-based development potential unless accompanied by parallel reforms in education, investment, and governance (Hartmann et al., 2020; Javaheri et al., 2024).

Nonetheless, by combining the analytical power of product space methodologies with a context-aware understanding of Iraq's political economy, the current study aims to offer a pragmatic roadmap for industrial policy formulation.

2. Methods and Materials

This study is applied in terms of its objective and descriptive-survey in terms of data collection, conducted as a cross-sectional survey. The aim of this article is to apply big data–based tools for policymaking in Iraq's industrial sector. Specifically, it utilizes data from 235 countries across 1,224 industrial product groups, extracted from the Harvard University's Atlas of Economic Complexity website. The dataset is vast and includes large matrices containing importer country codes, exporter country codes, product codes, and the monetary value of exports and imports among 235 countries—resulting in millions of records. For each product code, data is required for all 235 countries, indicating the large-scale nature of the data and the diversity of countries and products involved, thereby classifying the study as a big data project. The processing and analysis of such data volume are only feasible through algorithms and software with high data-handling capacity.

To achieve the defined objectives, the methodology first explains the calculation of the Economic Complexity Index (ECI) for countries and products based on the approach proposed by Hidalgo and Hausmann (2009). Then, the method for constructing the product space and network mapping based on the approach by Hidalgo et al. (2007) is described. Finally, the model presented by Alshamsi et al. (2018) is introduced to estimate the probability of activation for products without revealed comparative advantage.

2.1. *Calculating Country and Product Complexity*

To calculate the Economic Complexity Index (ECI) for countries and the Product Complexity Index (PCI), the methodology introduced by Hidalgo and Hausmann (2009) is used. Initially, the Revealed Comparative Advantage (RCA), as proposed by Balassa (1964), is calculated. This metric is then used to construct the country–product matrix (M_cp), which indicates in which products each country is competitive. The value of M_cp equals 1 if country *c* is competitively exporting product *p*, and 0 otherwise. The matrix M_cp is calculated based on RCA_cp using the following equation:

$$M_{cp} = \begin{cases} 1 & \text{if } RCA_{cp} \geq 1 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

Once the country–product matrix (M_cp) is computed, the diversity and ubiquity of products are calculated as follows:

$$\text{Diversity } (k_{c0}) = \sum_p M_{cp} \quad (2)$$

$$\text{Ubiquity } (k_{p0}) = \sum_c M_{cp} \quad (3)$$

Diversity reflects the number of products for which a country has a revealed comparative advantage, and ubiquity reflects how many countries have a revealed comparative advantage in a specific product. Finally, using diversity and ubiquity, and based on the method introduced by Hidalgo and Hausmann (2009), the ECI and PCI for 235 countries and 1,224 products are calculated.

2.2. *Method for Mapping the Product Space*

The product space is a geometric representation of products constructed based on the concept of proximity between different goods. The product space is built on the premise that if two products are related, they require similar inputs, infrastructure, technology, and institutions (Fortunato et al., 2019).

Two products are considered related if they are jointly exported by one or more countries. Hidalgo et al. (2007) used similarity in capabilities required for the production of a pair of products to build the network. Since these capabilities are neither observable nor measurable directly, they used the probability of simultaneous export of two products. Their proposed proximity index is defined as the probability of exporting product p given that product p' is already being exported:

(4) $Prox_{(p,p')} = (\sum_c M_{cp} \times M_{cp'}) / \max(k_{p0}, k_{p'0})$

Where M_{cp} equals 1 if country c competitively exports product p, and 0 otherwise.

To construct the product space using the proximity index, several criteria must be considered. First, all products must be connected. Second, the network must not be overly dense or sparse. To achieve this, Hidalgo et al. (2007) employed a Maximum Spanning Tree (MST) approach based on the proximity index.

Subsequently, Hidalgo et al. enhanced the connections by linking additional product pairs with the highest similarity scores, in addition to those already connected via MST. According to their approach, all pairs with a similarity index greater than 0.55 are connected. The product space thus constructed forms the foundation for industrial policymaking in Iraq.

2.3. *Model for Product Activation Probability*

Numerous studies have shown that diversification of production and exports is a path-dependent process. Countries tend to develop industries that are technologically similar to their current structure and are connected to existing industrial capabilities. Based on this view, Alshamsi et al. (2018) proposed a model to calculate the probability of activating exports for product i as follows:

(5) $P_i = B \times [(\sum_{j=1}^{n} a_{ij} \times M_j) / k_i]^\alpha$

In this equation, a_{ij} indicates whether products i and j are connected in the product space network. M_j indicates whether product j is currently exported by the country under analysis. k_i represents the number of products connected to product i in the network. B represents the probability of activating product i assuming all related products are already active. In the present computations, B is assumed to be 1. The parameter α determines the sensitivity of activation probability to the number of connected active products. For example, if $\alpha = 0$, it implies that the activation probability is equal across all nodes. If $\alpha = 1$, the probability increases linearly with the number of connected active products. Values of α greater than 1 imply a concave increase in activation probability with more active neighboring nodes. In this study, following Alshamsi (2018), α is set to 1.15.

Based on the activation probability results, products are classified into three categories: active, potentially active, and inactive. Products in which Iraq currently holds a revealed comparative advantage are classified as active. Potentially active products are those in which Iraq currently lacks a revealed comparative advantage, but the probability of activation is greater than zero. Products in which Iraq has no revealed comparative advantage and whose activation probability is zero are classified as inactive.

After identifying potentially active products, based on the importance of opportunity gain and product complexity indices, products are selected that, firstly, offer a positive opportunity gain and secondly, have a complexity index above the average of currently competitive export products. Opportunity gain refers to the improvement in a country's economic complexity index if the country develops a revealed comparative advantage in a specific product. It is calculated as follows:

(7) $OPG = \sum_{p'} [\phi(pp') / \sum_{p''} \phi(p''p')] \times (1 - M_{cp'}) \times PCI_{p'} - (1 - d_{cp}) \times PCI_p$

Where $\phi_{(pp')}$ is the proximity index defined in equation (4), $M_{cp'}$ is the country–product matrix, and PCI_p is the product complexity index of product p.

d_{cp} measures the distance between the products a country currently exports and other products it does not yet export. It is calculated as the sum of proximities between product p and all non-exported products by that country, divided by the total sum of proximities between product p and all products. If country c exports most of the products related to product p, d_{cp} approaches zero. If country c exports few of the related products, d_{cp} approaches one. The distance is calculated as follows:

(8) $d_{cp} = (\sum_{p'} (1 - M_{cp'}) \times \phi_{pp'}) / (\sum_{p'} \phi_{pp'})$

3. Findings and Results

This section begins by identifying the products among the 1,224 four-digit Harmonized System (HS) codes for which Iraq has revealed comparative advantage (RCA), based on the Balassa Index. Then, Iraq's production space is analyzed. Next, the status of products without revealed comparative advantage is determined based on the model of Alshamsi et al. (2018). Finally, considering constraints such as product complexity, opportunity gain, and product proximity, industrial policy opportunities for Iraq are identified.

The calculation of the Balassa Index (1973) for Iraq indicates that, among the 1,224 product categories examined based on four-digit HS codes, the country had a revealed comparative advantage in the export of 15 product codes in 2023. Table 1 displays the product names, their HS codes, RCA values, global trade volumes, Iraqi export values, Product Complexity Index (PCI), and relevant sectors.

Table 1

Iraq's Revealed Comparative Advantage Products in 2023

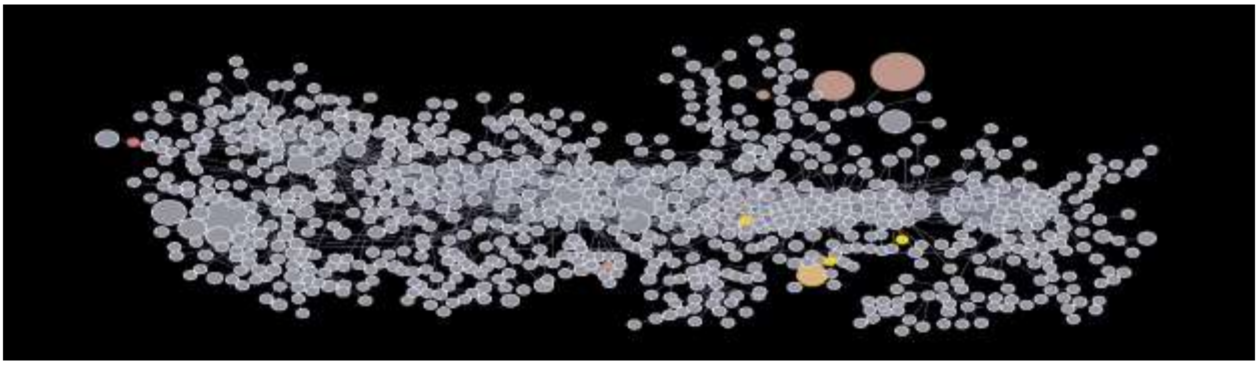
Row	Name	Code	Revealed Comparative Advantage (RCA)	World Trade	Iraqi Exports	Product Complexity Index (PCI)	Sector
1	Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens, fresh or dried	804	1.797392	1.46E+10	1.03E+08	-1.73	Agriculture
2	Peanut (ground-nut) oil and its fractions	1508	1.041762	6.78E+08	2154349	-1.53	Agriculture
3	High-temperature coal tar distillation products	2707	1.519671	2.94E+10	43371091	0.562	Minerals
4	Crude petroleum oils	2709	18.8854	1.09E+12	7.98E+10	-2.27	Minerals
5	Refined petroleum oils and preparations	2710	2.698033	7.45E+11	8.65E+09	-0.698	Minerals
6	Petroleum coke, bitumen, and other residues	2713	9.926365	2.12E+10	1.07E+09	-0.864	Minerals
7	Natural bitumen and asphalt	2714	1.128785	8.84E+08	91755501	-0.7	Minerals
8	Bituminous mixtures (e.g., mastics, cut-backs)	2715	1.100535	1.54E+09	6812094	-0.728	Minerals
9	Mixed alkylbenzenes and alkylnaphthalenes	3817	2.738457	2.05E+09	8716202	0.245	Chemicals
10	Tanned or crust sheep/lamb skins	4105	1.366686	8.38E+08	3433336	-1.96	Agriculture
11	Tanned or crust skins of other animals	4106	1.787691	5.08E+08	161808	-1.71	Agriculture
12	Bituminous mixtures (natural, petroleum)	7108	6.249074	3.93E+11	7.97E+09	-2.28	Minerals
13	Direct-reduced iron and high-purity iron	7203	1.610635	4.01E+09	684231	-1.03	Metals
14	Iron and nonalloy steel ingots	7206	14.426	4.68E+08	6297524	-0.702	Metals
15	Refined unwrought lead	7801	1.15114	6.52E+09	12283524	-1.66	Metals

Of Iraq's total exports amounting to USD 101 billion in 2023, more than 79% was attributed to crude oil (HS code 2709), and refined oil accounted for 8.6%. The most complex product in Iraq's export portfolio with a revealed comparative advantage was "high-temperature coal tar distillation products" (code 2707), with a PCI of 0.562. The second most complex product was "mixed alkylbenzenes and alkylnaphthalenes" (code 3817), with a PCI of 0.245. Among the 15 export products with RCA, 13 had negative complexity scores. The average PCI for these 15 products is -1.137, which reflects a low level of economic complexity in Iraq's export structure.

The production space is a network of all globally traded products. It consists of nodes and links connecting some of these nodes. In the product space, nodes represent products, and their proximity is defined based on the squared proximity matrix. Figure 1 illustrates Iraq's product space in 2023, constructed using the 1,224 four-digit HS codes.

Figure 1

Iraq's Product Space in 2023



The node sizes reflect each product's share in global trade. Highlighted nodes represent products in which Iraq has a revealed comparative advantage. Iraq's strongest RCA is in crude oil (codes 2709, 2710, and 2713).

Using big data related to the exports of 1,224 HS4 products across 235 countries, it was determined that Iraq holds a revealed comparative advantage in 15 products—listed in Table 1. As part of Iraq's industrial policy, the model by Alshamsi et al. (2018) was used to calculate the likelihood of achieving RCA in the remaining 1,209 products. Results show that the probability of activation is zero for 1,121 products and greater than zero for 88 products.

To identify potential industrial policy opportunities, three criteria were applied:

1. The product must provide a positive opportunity gain.
2. The product's complexity must be greater than the average complexity of Iraq's currently competitive exports (-1.137).
3. The product's proximity should be less than the median proximity of all industrial products in the space.

By calculating the distance, opportunity gain, and economic complexity for Iraq's industrial product codes, and applying the above filters, the study identified products on the edge of Iraq's capability frontier. Investment in these products can bring significant benefits to Iraq's industrial sector.

Of the 88 products with RCA activation probability greater than zero, 67 had a positive opportunity gain. If Iraq achieves RCA in these products, it would enhance the country's economic complexity. Next, among those 67, the products with complexity indices higher than -1.137 were selected. This filter yielded 32 products.

The final filter was proximity. By calculating the proximity metric, the study identified which products Iraq already exports and which others are close enough to be feasibly developed. Products with proximity below the median were retained, reducing the list to 11 products. The average PCI of these 11 products is -0.175.

Table 2 presents the name, HS code, Iraq's exports, world trade volume, RCA, proximity, PCI, activation probability, and corresponding sector for these 11 products.

Table 2

Products with Activation Potential for Iraq

Row	Name	Code	Iraq Export ($)	World Trade ($)	RCA	Distance	PCI	OPG	Pi	Sector
1	Stearic acid	1519	6070000	1.17E+10	0.1143	0.98824	-0.975	0.00014	10	Agriculture
2	Wire of iron or nonalloy steel	7217	10300000	8.01E+09	0.283684	0.987585	-0.378	0.000754	28	Metals
3	Animal or vegetable fats and oils and their fractions	1518	4110000	7.84E+09	0.1158	0.987063	-0.070	0.001069	12	Agriculture
4	Aluminum casks, drums, cans, boxes and similar containers	7612	5390000	6.52E+09	0.1826	0.986379	-0.017	0.001469	25	Metals
5	Other alloy steel in ingots	7224	2420000	3.89E+09	0.137093	0.992819	0.607	0.003859	28	Metals
6	Petroleum jelly	2712	6410000	3.49E+09	0.405651	0.989327	-0.363	0.001879	80	Minerals
7	Stranded wire, including slings and similar articles, of copper, not electrically insulated	7413	3710000	2.58E+09	0.317185	0.981232	0.143	0.002931	18	Metals

8	Zinc oxide; zinc peroxide	2817	996000	1.81E+09	0.035268	0.993189	0.055	0.001818	20	Chemicals
9	Stranded wire, cables, including slings and similar articles, of aluminum, not electrically insulated	7614	3340000	2.29E+09	0.322516	0.9878	-0.791	0.001054	50	Metals
10	Pitch and pitch coke	2708	1640000	2.02E+09	0.179116	0.983179	0.526	0.003095	40	Minerals
11	Other articles of lead	7806	292000	3.31E+08	0.194847	0.989587	-0.008	0.00214	10	Metals

The most complex recommended product is “Other alloy steel in ingots” with HS code 7224 and a Product Complexity Index (PCI) of 0.607. The activation probability for this product in Iraq is 28%, and it has the highest opportunity gain among the 11 proposed products. In 2023, out of the USD 3.89 billion global trade value for this product, USD 2.42 million was exported by Iraq. The top three exporters of this product in 2023 were Brazil (24%), Germany (8%), and Italy (7%).

In terms of complexity, the second recommended product for Iraq is “Pitch and pitch coke,” derived from coal tar, with HS code 2708 and a PCI of 0.526. Its activation probability is 40%. The leading exporters of this product in 2023 were China (39%), Belgium (12%), and South Korea (8%). Iraq's sole export destination for this product in 2023 was Qatar, with a trade value of USD 1.64 million.

The third highly complex recommended product is “Stranded wire of copper, not electrically insulated” with HS code 7413, having a PCI of 0.143 and an activation probability of 18% for Iraq. The global export value of this product was USD 2.58 billion in 2023, of which Iraq accounted for USD 3.71 million. The highest exporters were Turkey (22%), the United States (16%), and Germany (12%).

Regarding activation probability, the highest is associated with “Petroleum jelly” (HS code 2712), which has a PCI of -0.363 and an opportunity gain of 0.00188. The global trade value of this product in 2023 exceeded USD 3.49 billion, of which Iraq exported USD 6.41 million—97% to the United Arab Emirates and 3% to Turkey. The top three global exporters in 2023 were China (27%), the United States (10%), and Germany (9%).

4. Discussion and Conclusion

The results of this study reveal the significant potential for Iraq to diversify its industrial export base by leveraging product space analysis and economic complexity theory. The findings show that Iraq currently holds revealed comparative advantage (RCA) in only 15 out of 1,224 HS-4 product categories, with the majority of these products concentrated in the oil, minerals, and low-complexity agricultural sectors. This narrow export profile, coupled with the negative average Product Complexity Index (PCI) of -1.137 across these 15 products, reinforces the view that Iraq’s current export structure is highly dependent on low-complexity, resource-based products. These findings align with prior assessments indicating the underutilized nature of Iraq’s industrial potential and the urgent need for strategic diversification (Mayer et al., 2023; Ola Alii & Falah khalaf, 2022).

Product space mapping further illustrates that while Iraq's current export basket lies within a sparse and low-complexity region of the product space, there are several nearby products with significantly higher complexity and opportunity gain. Specifically, the study identified 88 products with a non-zero activation probability, of which 67 products showed a positive opportunity gain (OPG). Of these, 32 products also had a higher PCI than Iraq’s average and 11 products met the final criterion of having a below-median proximity distance. Notably, products such as “other alloy steel in ingots” (HS code 7224), “pitch and pitch coke” (HS code 2708), and “stranded copper wire” (HS code 7413) were found to have high complexity and activation potential, making them attractive targets for strategic industrial development. This outcome is consistent with the core premise of economic complexity theory that countries can move more efficiently into products that are “close” to their current capabilities in the product space (Alshamsi et al., 2018; Hartmann et al., 2020).

One of the most compelling results of this study is the high opportunity gain and activation probability associated with products in the metals and petrochemicals sectors. This observation resonates with the findings of other studies on the Middle East, particularly in the context of Iran and Saudi Arabia, which have demonstrated that resource-rich countries can achieve meaningful diversification by targeting technologically adjacent sectors such as refined metals, industrial chemicals, and machinery components (AlOtaibi & Sallam, 2025; Dadgar & Fahimi, 2024; Khosravi et al., 2020). Furthermore, these products not only offer higher complexity but also have significant global market volumes, providing Iraq with access to competitive international markets. For instance, “petroleum jelly” (HS code 2712), though still resource-based, exhibits high proximity and export potential, having already established a modest presence in Iraq's trade portfolio. This demonstrates a feasible entry point into higher-value downstream petroleum products (Pinheiro, 2025).

Another major implication of the results is the confirmation that Iraq's capability frontier is not entirely barren. While only a small fraction of the total product space is currently within reach, the identified 11 products at the frontier suggest a clear path forward for gradual and strategic capability upgrading. This supports the broader literature asserting that export diversification is a path-dependent process, where countries tend to develop industries that share institutional, infrastructural, and technological traits with their existing production capabilities (Sagheb et al., 2023; Tran & Freytag, 2025). The model employed in this study, based on the framework proposed by Alshamsi et al. (2018), effectively captures this trajectory by estimating product activation probabilities through proximity, PCI, and OPG. The prioritization of products meeting all three criteria—positive OPG, PCI above national average, and below-median distance—offers a robust, data-driven basis for industrial policymaking.

The study also contributes to the growing body of research advocating the use of big data and network science in industrial development strategy formulation. The utilization of global trade data from 235 countries and over a thousand product codes reflects the kind of large-scale, granular analysis emphasized by scholars in the field of economic forecasting and complexity science (Blazquez & Domenech, 2018; Javaheri et al., 2024). This methodological rigor ensures that the identified opportunities are not based on intuition or sectoral biases but are anchored in measurable, globally benchmarked indicators. Such an approach is particularly critical for Iraq, where policy misalignment and fragmented development efforts have historically impeded structural transformation (Ahmadian Divkoti et al., 2019).

From a policy perspective, the identification of specific high-potential products serves as an essential input for targeted investment, infrastructure planning, and capacity-building initiatives. The evidence suggests that products such as industrial metals, petrochemicals, and technical-grade chemical compounds can act as stepping-stones toward a more complex and diversified industrial structure. These sectors are not only technologically adjacent to Iraq's existing capabilities but also offer relatively low barriers to entry and strong backward and forward linkages. Such findings resonate with earlier proposals made in regional development planning documents that emphasize the importance of cluster-based industrial strategy and regional value chain integration (Sezai, 2020; Syrquin & Chenery, 1989).

Moreover, the study highlights the centrality of the Product Complexity Index in identifying not just feasible but impactful diversification options. While many products may be "close" in terms of capabilities, only those with higher-than-average complexity contribute meaningfully to the improvement of Iraq's Economic Complexity Index. This underscores the importance of moving beyond simple proximity-based models to integrated frameworks that also account for potential developmental impact. Indeed, the simultaneous use of PCI, OPG, and proximity distinguishes this study from conventional RCA analyses, offering a multidimensional approach to industrial opportunity assessment (Simaee et al., 2021; Zobeiri, 2025).

The findings also offer an empirical validation of the argument that complexity-informed policy tools can enhance the efficiency and effectiveness of industrial policy in developing countries. By focusing on the capability frontier rather than isolated sectoral growth, policy-makers can mitigate the risks of industrial failure and technological mismatch. This approach is particularly pertinent in post-conflict and resource-dependent contexts like Iraq, where institutional stability and policy continuity are often in flux. The evidence from this study supports the idea that even marginal increases in the complexity of Iraq's export basket can yield outsized benefits in terms of GDP growth, employment generation, and technological upgrading (Breen et al., 2017; Hartmann et al., 2020).

Despite the robust analytical framework and comprehensive dataset, this study faces several limitations. First, the analysis relies heavily on trade data, which may not fully capture informal economic activities or domestic production capabilities not yet reflected in export flows. Second, the model assumes stability in global demand and trade structures, which may not hold in the face of geopolitical disruptions or rapid technological change. Third, the activation probabilities are derived from proximity and similarity measures, which do not account for non-economic barriers such as political risk, regulatory inefficiencies, or workforce limitations specific to Iraq's domestic context. Additionally, some data limitations in the Harmonized System (HS) coding and global databases may introduce bias or underreport emerging sectors.

Future studies could enhance the current findings by incorporating firm-level data and supply chain structures to better understand the microfoundations of capability development in Iraq. Moreover, integrating political economy variables—such as institutional quality, governance indicators, and public investment trends—could refine the predictive accuracy of activation models. Longitudinal analyses examining how Iraq's product space evolves over time and in response to specific policy interventions would also provide valuable insights. Comparative studies with other post-rentier economies in the Middle East and North Africa (MENA) region may offer additional benchmarks and contextual relevance.

Policy-makers in Iraq should use the identified high-potential products as entry points for targeted industrial strategies. Investment incentives, infrastructure development, and skills training programs should be aligned with these priority sectors. Establishing public–private partnerships and regional export clusters around these products can accelerate capability accumulation. Moreover, fostering a national innovation system, improving trade logistics, and ensuring macroeconomic stability will be critical to realizing the diversification goals. Finally, institutionalizing the use of economic complexity tools in national planning can ensure evidence-based decision-making and long-term policy coherence.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were considered.

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