Analysis of Pakistan's Comparative Advantage in Sugar Industry Products

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Abstract

This study evaluates Pakistan's comparative advantage in sugar industry products by analyzing export data from 2013 to 2022. It examines trends and performance of Pakistan's sugar industry products relative to global competitors using the normalized revealed comparative advantage (NRCA) index. The NRCA index is preferred as it addresses the conventional need to normalize comparative advantage measures across countries and products, thereby providing more accurate insights into the competitiveness and magnitude of various countries' comparative advantages in particular product categories. The results indicate that Pakistan possesses a clear comparative advantage in four categories of sugar products, while it has an unstable and wavering comparative advantage in HS 1701 (table sugar). The magnitude of this advantage comparative advantage is better and consistent in three categories of sugar products and inconsistent in the remaining two categories. Despite these advantages, Pakistan's export shares across all product categories are low, indicating that the country has not capitalized on export opportunities in the international market. The results highlight the need for Pakistan to enhance export promotion efforts, especially in processed and value-added sectors, and to undertake relevant policy reform.

Keywords: Sugar industry; NRCA; sugar export; competitiveness.

JEL Classification: L69, Q13

1. Introduction

The sugar industry occupies a significant position within Pakistan's economy, serving as a major source of employment and income for millions across the agricultural and industrial sectors. With a strong agricultural foundation and a traditional industrial base, the sugar industry plays a vital role in supporting the rural economy. Over time, Pakistan's sugar sector has developed from scratch to a self-sufficient and export-oriented industry that creates employment and earns foreign exchange. Despite this progress, the sector has encountered several challenges in the global market, such as unstable production levels, trade barriers, and

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low market share. From 2013 to 2022, the exports of global sugar industry products grew by 2.7%, while those of Pakistan declined by −1.7%, raising concerns about the performance of the fifth-largest cane sugar producing country in the world i. Structural inefficiencies and fear of changing government policies on production and export are significant causes of the minimal market share (Manzoor et al., 2023). Although the sector has gone through periods of success, it currently, Pakistan is currently experiencing falling rates of export shares and an unpredictable context of trade. The global competitiveness of Pakistan's sugar industry depends on strategic improvements and insights into product-specific comparative advantages and opportunities.

Cane sugar is the predominant source of sugar globally, with 80% of global sugar sourced from sugarcane and only 20% sourced from sugar beets (ISO, n.d.). Brazil, India, Thailand, China, and Pakistan are the top five cane sugar-producing countries in the world (PSMA, 2023), collectively contributing to 70% of global sugar (Qureshi & Afghan, 2020). The global volume of sugar and its related products traded annually is increasing. Demand for sugar is influenced by population growth, per capita income, the price of sugar and alternative sweeteners, and health-related concerns (ISO, n.d.).

The multiple by-products of sugar exert a spillover effect on demand generation, making it a profitable venture. Increasing globalization and minimizing trade barriers have encouraged competition, where firms strive to gain "market share," efficiency, uniqueness, profitability, and performance through research, development, and innovation to achieve competitiveness (Banerjee, 2005). The sugar industry significantly influences global trade through its contributions to economic, job, and rural development in many countries (Govindasamy et al., 2024). Sugar and its derivative products, such as confectioneries, are strategically significant to developed and developing countries, as they provide essential sweeteners for the human body. The global sugar industry has undergone technological advancements that enable multiple by-products and related value-added goods. The primary products produced from sugarcane include sugar, molasses, bagasse, and filter cake. Bagasse is primarily used for energy generation and animal feed. whereas sugar and molasses are mainly used for value-added products such as sugar confectionery and ethyl alcohol. More than 50% of the sugar produced in Pakistan is used in sugar confectionery, bakery, and beverages (USDA, 2023). Therefore, in addition to HS 1701 (table sugar), HS 1702 (other sugars), HS 1703 (molasses), and HS 2207 (ethyl alcohol), this study treats HS 1704 (sugar confectionery) as a sugar industry product ii. Exports of these products directly generate demand for the sugar industry.

In the context of exporting different categories of sugar products, the existing literature has not provided a product-wise competitiveness analysis or a comparative advantage for nations. Accordingly, this study seeks to evaluate the competitiveness and comparative advantage of Pakistan and other major cane sugar-producing countries in terms of exporting

sugar industry products. It also aims to understand the opportunities for Pakistan's sugar industry exports. Identifying these opportunities is essential for developing effective strategies that enable Pakistan to sustain competitive sugar production and convert this opportunity into a source of earning foreign exchange. This study uses the normalized revealed comparative advantage (NRCA) index proposed by Yu et al. (2009) to provide insights into countries' comparative advantage via their export performance from 2013 to 2022. The export data were obtained using four-digit HS codes from the International Trade Centre (ITC)'s trade map database.

The following sections of the paper are organized to discuss the literature review, method, results, analysis, discussion, and conclusions.

2. Literature Review

The existing literature on the sugar industry highlights that various countries have historically supported sugar production and the diversification of its by-products through various policy measures, including direct and indirect subsidies. Despite its significant socioeconomic benefits, the sugar sector faces multiple trade barriers and remains heavily regulated worldwide (OECD, 2007). Numerous policy interventions in the sugar trade to protect domestic consumer interests (OECD, 2007). Contemporary sugar industries have a range of by-products and related commercial value products to increase profits and sustainability through technological advancements. Through technology, consumers can switch among multiple products to optimize returns, particularly during periods of low sugar prices.

Brazil, a global leader in sugar production and export, has historically supported its sugar industry through policy measures, such as subsidies to continue sugar production and diversify its by-products for import substitution and generate foreign exchange and employment. Currently, Brazil holds the largest global market share of sugar and ethyl alcohol, supported by the world's largest area under cultivation for sugarcane. According to Banerjee (2005), Brazil's competitiveness in sugar industry products is derived from natural resources such as climatic conditions; production efficiency, such as economies of scale; vertical integration switch between sugar and ethanol; and government support policies on the production of ethyl alcohol, such as subsidies. Brazil aims to increase sugar production efficiency by harnessing natural resources, implementing a coherent competitiveness strategy, and formulating government policies that are tailored to national circumstances and have a major influence on the creation of industry and firm competitiveness (Banerjee, 2005). Zimmermann and Zeddies (2002) also observed that Brazil benefits from its favorable natural, economic, and political conditions. Brazil's "PROALCOOL" program, launched in 1975, helped diversify industrial outputs such as the production of ethyl alcohol for use as car fuel (Banerjee, 2005). Brazil's dominance in the modern sugar industry stems from its

capacity to produce diverse by-products and interplay among different products to stabilize the market and maximize returns.

India is the second-largest producer of sugar globally (PSMA, 2023), contributing 15% to the global sugar production (Soloman, 2014). As the second-largest producer and the largest consumer of sugar worldwide (PSMA, 2023), India hosts a dynamic sugar industry with great socio-economic importance and a turnover ranging from Rs. 80 to 85 crores per annum for sugarcane and related economic activities (Soloman, 2014). It not only meets the rising domestic demand every year but also contributes to foreign exchange for the country through continuous exports. The sugar industry in India is also supported through multiple policy interventions, such as subsidies to retain global shares in exports and fostering year-on-year improved production. The sugar sectors in India and Thailand has benefited from substantial government support in the form of subsidies, export incentives, and investments in infrastructure (Chakraborty & Sahu, 2020; Sheetal & Kumar, 2015). Moreover, the Indian sugar industry is diversified and can capitalize on a range of by-products. Sheetal and Kumar (2015) analyzed the competitiveness of India's sugar industry using the revealed comparative advantage (RCA) and export specialization index. They found that while India demonstrates a comparative advantage at the aggregate level, its performance at the disaggregated level remains weaker. The country's export competitiveness has not been consistent across the years and is not uniform across all product categories.

Thailand and China are ranked as the third and fourth largest producers of cane sugar globally, respectively. Thailand has established itself as a global pillar of sugar exports after capitalizing on policy support and production efficiencies. While sugar remains the primary product of the industry, by-products from sugar plants, such as bagasse and molasses, are utilized to generate surplus electricity and ethanol (Sathitbun-anan et al., 2015). Thailand produces 1.93 million tons of ethyl alcohol per day from molasses (Chunhawong et al., 2018), which supports the domestic industry and exports. Government policies have supported crop expansion through crop zoning and the use of sugarcane for the production of renewable energy from bagasse and molasses, alongside the continued stable production of sugar (Sriroth et al., 2016). Thailand's low productivity is offset by low wages and relatively relaxed environmental and social standards (Zimmermann & Zeddies, 2002). In contrast, China's sugar industry mostly serves as an import substitution to avoid imports of sugar and related products. China strives to ensure at least 70% of its sugar consumption through domestic production (Li et al., 2015). The sector is progressing not only to increase sugar production but also to integrate sugarcane as products under government developmental policies, technological innovation, and improved management practices (Li et al., 2006).

Pakistan's sugar industry. By comparison, is constrained by unpredictable industry-focused policies that generate uncertainty. Hence, individual producers and exporters faced a reduced capacity for effective planning and competitive investment. Inconsistent and

industry-focused policy measures, such as export bans from time to time and price control subsidies influenced by the political agenda rather than a broader strategy toward long-term international competitiveness, are major challenges in its sugar industry (Chakraborty & Sahu, 2020; Li & Pan, 2023). Additional supply-side barriers, including high production costs, less mechanization, and unutilized resources, make Pakistan's sugar sector incompetent compared with that of other sugar-exporting countries (Khushk et al., 2011). Moreover, agricultural and macroeconomic policies fail to align with Pakistan's inherent comparative advantage in sugarcane production because during the import-substitution regime, Pakistan, had clear comparative advantages in cane production whereas, during the export promotion regime, Pakistan, it was at a disadvantage in terms of cane production (Ali & Khan, 2012). According to Iqbal et al. (2014), mill inefficiency is one of the reasons for low sugar production in Pakistan because the country's juice extraction efficiency is 90%–92% instead of the 98% global average. Govındasamy et al. (2024) concluded that Pakistan has negative Relative Trade Advantage values in sugarcane owing to competitive challenges and domestic focus. These studies predominantly focus on competitiveness through production inefficiencies, while overlooking international market dynamics and demand-side factors. In addition, they do not reveal the product-wise competitiveness within sugar industry products.

The classical theory of comparative advantage suggests that the comparative advantage of nations is driven by technological differences. In contrast, Heckscher–Ohlin indicated that comparative advantage arises from factor endowments—such as the availability of cheap labor and capital—which make production of a country more competitive relative to that of other nations. However, some indices, such as the RCA index by Balassa and the NRCA index by Yu et al. (2009) have been developed to ascertain a country's comparative advantage, particularly for commodity trade, and measure the magnitude. Several researchers have used the RCA and NRCA indices to evaluate the comparative advantage of countries in terms of agricultural commodities. Yu et al. (2010) employed the NRCA index to assess the comparative advantage of Hawaii's agricultural exports to the USA. Sheetal and Kumar (2015) examined India's sugar industry in terms of export specialization and competitiveness using Balassa's RCA and export specialization. Zdráhal (2024) analyzed the comparative advantage of agri-food industries in selected Central and Eastern European countries using the NRCA index. Ahmad et al. (2024) applied RCA, relative export advantage (RXA), and relative competitiveness (RC) indices to assess the competitiveness of Pakistan's major agricultural products of Pakistan.

The literature highlights the significance of industrial diversification through the production of the sugar industry by-products. The main sugar producing and exporting countries continue to benefit from the multiple by-products of the industry, which not only create jobs but also earn foreign exchange. Despite this, limited studies exist on product-wise competitiveness and comparative advantage analysis of the main sugar producing countries. Given the limited literature on the product-wise competitiveness of the sugar industry,

particularly research that uses export performance and quantifies the comparative advantage of nations in producing sugar industry products, this study offers a novel analysis of the product-wise competitiveness and comparative advantage of Pakistan and other top cane sugar producing countries. This study focuses on identifying the comparative advantage for each country in producing each category of sugar industry product categories within a defined policy framework.

3. Methodology

The concept of comparative advantage, introduced by David Ricardo in 1817, provides a theoretical understanding of international markets. It suggests that countries should specialize in producing goods for which they incur the lowest opportunity cost. Researchers have applied different methods to determine the comparative advantage of nations. Some approaches are based on pre-trade relative prices, whereby a country has a comparative advantage when its domestic prices are lower than international prices (Sheetal & Kumar, 2015). Additionally, empirical models have been developed to determine countries' comparative advantage across commodities. The RCA index of Balassa is the most popular index for determining nations' comparative advantage through export data across particular commodities.

$$RCA_{ij} = \frac{\left(\frac{X_{ij}}{X_i}\right)}{\left(\frac{X_{wj}}{X_w}\right)}, \quad \text{----------} \quad (1)$$

where X_{ij} is the export value of commodity j by country i; X_i denotes the total export value of country i; X_{wj} represents the global export value of commodity j; and X_w is the total global export value.

The RCA index is interpreted as follows:

If $RCA_{ij} > 1$, then country i has a comparative advantage in exporting commodity j. If $RCA_{ij} < 1$, then country i has a comparative disadvantage in exporting commodity j. Then, if $RCA_{ij} = 1$, then country i holds a neutral comparative advantage over commodity j[iii].

Although the RCA index has been useful in indicating a nation's comparative advantage based on the export data, it possesses certain limitations that lead to misleading interpretations. Hillman (1980) and Yeats (1985) noted that the RCA index of Balassa (BRCA index) can theoretically indicate whether a country has a comparative advantage in a specific commodity. This is because its magnitude lacks ordinal or cardinal properties. Another shortcoming of the BRCA index is its asymmetry, that is, the BRCA index has a fixed lower bound of 0, with 1 as the comparative advantage neutral point, whereas its upper bound is

generally not defined. Therefore, the mean value of a country or a commodity's BRCA scores in general is not the same. This implies that identical BRCA values may reflect different levels of comparative advantage for different countries or commodities, casting doubt on the comparability of Balassa's RCA index across either country or commodity (Yu et al., 2009). In such cases, the RCA may be overestimated in these cases, leading to erroneous interpretations (Siggel, 2006).

NRCA provides a fair, normalized measure that overcomes the limitations of RCA and produces a zero-sum index that enables appraisal across time and commodity classes. This symmetrical property is particularly relevant for competitive and dynamic industries such as the sugar industry. NRCA helps eliminate the size bias and presents a clearer view of the true relative comparative advantage. This study also uses the NRCA indices of Yu et al. (2009) to provide a more sophisticated, balanced table-based metric that subtracts the share of a country from the global production of a given commodity to overcome these shortcomings. The following is the NRCA formula:

$$NRCA_{ij} = \frac{X_{ij}}{X_w} - \left(\frac{X_i}{X_w} X \frac{X_{wj}}{X_w}\right), \text{----------} \quad (2)$$

Where $NRCA_{ij}$ represents the RCA index of commodity j in country i; X_{ij} denotes the export of commodity j by country i; X_i is country i's total export; X_{wj} is commodity j's global export; and X_w refers to the total global exports. According to the value of the index, $NRCA_{ij} > 0$ indicates that country i has a comparative advantage in the export of commodity j; $NRCA_{ij} < 0$ represents the comparative disadvantage of commodity j of country i; and $NRCA_{ij} = 0$ represents the neutral comparative advantage of commodity j in country i.

The NRCA improves upon the RCA by balancing asymmetrical comparisons and normalizes the range. Thus, all commodities and timeframes can be directly compared with one another. Moreover, NRCA introduces a zero-sum characteristic, making it particularly useful when tracking competitiveness trends across highly contested markets, such as the sugar industry. Several researchers have utilized the NRCA index to study agricultural commodities. For instance, Yu et al. (2010) applied this index to assess the comparative advantage of Hawaii's agricultural exports, while Ashadullah (2020) employed NRCA for a competitiveness analysis of Bangladesh's ready-made garment sector.

The present study employs the NRCA index to examine the competitiveness and comparative advantage of Pakistan's sugar industry products in the global market. It relies on secondary data from the ITC's trade map database, which provides insights into global trade flows, including sugar industry products from various countries. NRCA is preferred due to its ability to measure the magnitude of comparative advantage across time, commodities, and countries. In summary, the data and index offer a comprehensive overview of a country's relative export performance. This analysis uses NRCA to assess Pakistan's RC and identify potential strategic policy interventions for the sugar industry.

4. Results and Analysis

The analysis of the global products' trade of the sugar industry reveals positive but low growth compared with overall global merchandise trade. From 2013 to 2022, global merchandise exports grew by 3% on average, whereas sugar industry products exports grew by 2.17%. Pakistan's exports of sugar industry products declined by -1.73% during that period. As presented in Table 1, Pakistan started with high-value exports of sugar products, that is, approximately USD 990,129 million in 2013, which subsequently saw a steep drop over the years, decreasing to as low as USD 499,914 million in 2016. This decline indicates that the country is having increasing difficulty maintaining its position as an exporter of sugar products, a situation worsened by trade barriers that have led to low input supplies. Conversely, global sugar exports followed an upward trend, rising from USD 59 billion in 2013 to more than USD 71 billion, representing a global demand that Pakistan has not taken advantage of. After falling dramatically in 2015–2016, Pakistan's sugar exports temporarily rebounded in 2018 to approximately USD 959 million. However, this turnaround was only short term and policy induced, caused by government subsidies (freight support) in times of low international prices (PSMA, 2017). The reduction in export subsidies stifled domestic stocks briefly, picking up in 2017, but the low demand remained, which made industries produce less sugar and farmers grow less sugarcane. The Competition Commission of Pakistan (2010) declared that subsidies provide short-term relief but do not provide long-term competitiveness. These subsidies do not provide sustained benefits to the sugar industry because the industry returns to normal production after a temporary surge.

Table 1
Analysis of Pakistan's sugar industry exports (figures in thousands)

Year	Exports of Pakistan (HS1701, 1702, 1703, 1704, and 2207)	Global exports (HS1701, 1702, 1703, 1704, and 2207)	Total merchandise exports of Pakistan	Total global merchandise exports
2013	$990,129	$59,073,205	$25,120,883	$18,858,694,469
2014	$788,488	$53,159,973	$24,722,182	$18,862,720,756
2015	$666,175	$46,674,045	$22,089,018	$16,416,919,480
2016	$499,914	$51,685,174	$20,533,793	$15,923,091,279
2017	$894,510	$20,253,639	$21,911,598	$17,562,644,182
2018	$959,254	$49,778,524	$23,778,621	$19,327,913,341
2019	$665,999	$47,726,095	$23,818,817	$18,748,620,037
2020	$457,413	$52,531,721	$22,245,688	$17,499,876,321
2021	$554,421	$59,303,370	$28,880,006	$22,138,761,100
2022	$845,961	$71,689,930	$31,175,925	$24,487,201,641

Source: ITC's trade map database

Under Pakistan's current policy framework, the export of HS 1701 (table sugar) is restricted under the export policy order. The Ministry of Industries and Production, in collaboration with provincial governments, monitors sugar stocks in the country and allows the export of surplus stocks after maintaining enough reserve stocks to cater to domestic demand until the next production season.

Using the NRCA index, Table 2 provides a comparative analysis of export performance and comparative advantages for five major cane sugar producing countries, namely, Brazil, India, Thailand, China, and Pakistan, for five major sugar industry products—HS 1701 (table sugar), HS 1702 (other sugars), HS 1703 (molasses), HS 1704 (sugar confectionery), and HS 2207 (ethyl alcohol). This analysis spans from 2013 to 2022, offering insights into global trade dynamics and emerging opportunities in the sugar market.

Table 2

NRCA values and export share percentages of the sugar industry products of Pakistan and major cane sugar-producing countries

Year	Rank	HS 1701 (Table sugar)			HS 1702 (Other sugars)			HS 1703 (Molasses)			HS 1704 (Sugar Confectionary)			HS 2207 (Ethyl alcohol)		
		Country	NRCA	Export Share %	Country	NRCA	Export Share %	Country	NRCA	Export Share %	Country	NRCA	Export Share %	Country	NRCA	Export Share %
2022	1	Brazil	4.316	34.57	Thailand	0.015	4.92	India	0.010	21.46	Pakistan	0.004	0.81	Brazil	0.638	12.25
	2	India	2.105	18.04	Pakistan	0.003	0.93	Pakistan	0.002	3.81	Thailand	0.000	1.24	Pakistan	0.234	4.12
	3	Thailand	1.099	9.61	India	-0.001	1.55	Thailand	0.000	1.80	Brazil	0.000	1.42	Thailand	-0.066	0.04
	4	Pakistan	-0.017	0.00	Brazil	-0.004	0.28	Brazil	-0.001	0.01	India	-0.004	1.17	India	-0.068	0.69
	5	China	-1.861	0.36	China	-0.014	11.08	China	-0.007	0.01	China	-0.032	9.43	China	-0.855	0.08
2021	1	Brazil	3.802	33.94	Thailand	0.009	3.75	India	0.009	19.49	Pakistan	0.003	0.69	Brazil	0.417	9.69
	2	India	1.515	14.80	Pakistan	0.002	0.76	Thailand	0.000	1.38	Thailand	0.000	1.23	Pakistan	0.175	3.66
	3	Thailand	0.544	5.88	India	-0.001	1.50	Pakistan	0.000	0.01	Brazil	0.000	1.27	Thailand	-0.056	0.08
	4	Pakistan	-0.015	0.00	Brazil	-0.004	0.23	Brazil	-0.001	0.01	India	-0.004	1.17	India	-0.058	0.60
	5	China	-1.736	0.27	China	-0.020	9.79	China	-0.008	0.01	China	-0.043	8.00	China	-0.742	0.18
2020	1	Brazil	2.834	21.93	Thailand	0.010	4.20	India	0.005	10.52	Pakistan	0.003	0.57	Brazil	0.612	11.74
	2	India	1.210	10.43	Pakistan	0.002	0.64	Thailand	0.003	6.30	Thailand	0.000	1.30	Pakistan	0.191	3.42
	3	Thailand	0.823	7.33	India	-0.002	0.97	Pakistan	0.000	0.53	Brazil	0.000	1.14	India	-0.029	1.07
	4	Pakistan	-0.016	0.01	Brazil	-0.003	0.23	Brazil	-0.001	0.00	India	-0.004	0.95	Thailand	-0.068	0.14
	5	China	-1.980	0.30	China	-0.009	12.17	China	-0.008	0.02	China	-0.045	7.73	China	-0.714	2.48
2019	1	Brazil	3.350	31.84	Thailand	0.002	2.01	India	0.004	10.26	Pakistan	0.003	0.66	Brazil	0.475	11.50
	2	Thailand	1.443	14.51	Pakistan	0.002	0.67	Thailand	0.003	7.04	Thailand	0.002	1.61	Pakistan	0.166	3.73
	3	India	0.725	8.36	China	0.001	13.69	Pakistan	0.000	0.59	Brazil	0.000	1.20	Thailand	-0.053	0.15
	4	Pakistan	0.104	1.08	India	-0.003	0.89	Brazil	-0.001	0.01	India	-0.005	0.97	India	-0.060	0.43
	5	China	-1.410	0.43	Brazil	-0.003	0.28	China	-0.006	0.02	China	-0.032	8.28	China	-0.607	0.15
2018	1	Brazil	5.758	49.90	China	0.004	14.25	India	0.002	6.42	Pakistan	0.002	0.49	Brazil	0.406	10.28
	2	Thailand	1.191	11.36	Pakistan	0.002	0.71	Pakistan	0.001	2.13	Thailand	0.001	1.52	Pakistan	0.230	5.25
	3	India	0.283	4.07	Thailand	0.000	1.22	Thailand	0.001	2.93	Brazil	-0.001	1.11	India	-0.029	1.04
	4	Pakistan	0.187	1.70	India	-0.001	1.41	Brazil	0.000	0.01	India	-0.004	0.99	Thailand	-0.048	0.23
	5	China	-1.475	0.44	Brazil	-0.003	0.27	China	-0.005	0.02	China	-0.031	7.87	China	-0.556	0.52
2017	1	Brazil	6.289	38.52	China	0.005	14.41	Pakistan	0.001	2.45	Pakistan	0.005	0.89	Brazil	0.401	9.68
	2	Thailand	1.260	8.81	Pakistan	0.002	0.82	Thailand	0.001	2.76	Thailand	0.001	1.52	Pakistan	0.211	4.58
	3	India	0.266	3.26	Thailand	0.000	1.27	India	0.000	1.33	Brazil	0.000	1.22	India	-0.022	1.21
	4	Pakistan	0.175	1.16	India	-0.001	1.26	Brazil	-0.001	0.01	India	-0.004	1.06	Thailand	-0.052	0.24
	5	China	-2.131	0.31	Brazil	-0.003	0.26	China	-0.006	0.01	China	-0.035	7.56	China	-0.575	0.82
2016	1	Brazil	0.635	38.25	China	0.004	14.63	Thailand	0.002	5.37	Pakistan	0.004	0.70	Brazil	0.510	12.40
	2	Thailand	0.121	8.39	India	0.002	2.39	Pakistan	0.000	0.85	Thailand	0.001	1.53	Pakistan	0.151	3.45
	3	India	0.063	5.31	Pakistan	0.002	0.76	India	0.000	2.16	Brazil	0.001	1.25	India	-0.014	1.33
	4	Pakistan	0.006	0.46	Thailand	0.000	1.39	Brazil	0.000	0.38	India	-0.005	0.92	Thailand	-0.048	0.27
	5	China	-0.223	0.30	Brazil	-0.003	0.16	China	-0.007	0.33	China	-0.039	7.66	China	-0.588	0.35

Table to be continued...

2015	1	Brazil	0.449	33.09	Pakistan	0.002	0.76	Thailand	0.002	4.19	Pakistan	0.004	0.74	Brazil	0.486	12.42
	2	Thailand	0.142	11.41	India	0.001	1.90	India	0.001	3.00	Thailand	0.001	1.38	Pakistan	0.182	4.34
	3	India	0.050	5.14	Thailand	0.000	1.30	Pakistan	0.000	0.78	Brazil	0.000	1.22	India	0.006	1.74
	4	Pakistan	0.012	1.01	China	-0.002	13.27	Brazil	-0.001	0.01	India	-0.006	0.74	Thailand	-0.031	0.57
	5	China	-0.193	0.20	Brazil	-0.003	0.21	China	-0.007	1.29	China	-0.039	7.92	China	-0.588	0.30
2014	1	Brazil	0.485	35.00	Pakistan	0.001	0.57	Thailand	0.002	4.14	Pakistan	0.004	0.84	Brazil	0.429	11.85
	2	Thailand	0.128	10.13	India	-0.001	1.49	Pakistan	0.001	1.57	Brazil	0.001	1.25	Pakistan	0.180	4.61
	3	India	0.035	4.13	Thailand	-0.001	0.93	India	0.000	1.32	Thailand	0.000	1.18	India	0.009	1.91
	4	Pakistan	0.014	1.08	Brazil	-0.003	0.17	Brazil	-0.001	0.00	India	-0.006	0.77	Thailand	-0.040	0.21
	5	China	-0.176	0.14	China	-0.004	11.09	China	-0.006	1.34	China	-0.033	7.18	China	-0.479	0.48
2013	1	Brazil	0.607	36.77	Pakistan	0.001	0.41	Thailand	0.002	5.50	Pakistan	0.003	0.66	Brazil	0.935	21.84
	2	Thailand	0.131	8.88	Thailand	-0.001	0.87	Pakistan	0.002	4.11	Thailand	0.002	1.63	Pakistan	0.183	4.17
	3	Pakistan	0.024	1.53	India	-0.001	1.41	India	0.001	3.21	Brazil	0.001	1.48	India	0.022	2.27
	4	India	0.021	3.00	China	-0.003	10.68	Brazil	-0.001	0.00	India	-0.007	0.68	Thailand	-0.017	0.84
	5	China	-0.198	0.13	Brazil	-0.004	0.11	China	-0.006	1.14	China	-0.030	6.67	China	-0.510	0.47

According to the data, from 2013 to 2022, the NRCA values indicate that Brazil's HS 1701 (table sugar) and HS 2207 (ethyl alcohol) had significant positions in global sugar and ethyl alcohol markets across the country's high export shares. For the five categories (i.e., HS 1701–HS 1704 and HS 2207), Brazil had a high comparative advantage in HS 1701 (table sugar), with its export shares peaking at 49.5% in 2018 and continuously high NRCA annual values of 6.28 in 2017. This performance in exports and comparative advantage is exceptionally high, reflecting the policy direction that enabled Brazil to remain dominant in the global market.

India, as the second-largest producer of sugar, continues to be a moderate exporter. Its export shares are relatively high in most categories, with NRCA values varying widely. For example, India is moderately competitive in HS 1701 (table sugar), reaching over 2.10 in 2022. In contrast, its NRCA values are typically around 0 or negative in other categories, such as HS 1702 (other sugar), HS 1703 (molasses), HS 1704 (sugar confectionery), and HS 2207 (ethyl alcohol). Thailand maintained a consistent position in terms of its global sugar exports. Its NRCA values were positive in a few categories, including HS 1701 (table sugar), HS 1702 (other sugars), HS 1703 (molasses), and HS 1704 (sugar confectionery), but negative for HS 2207 (ethyl alcohol). While Thailand does not have a comparative advantage as Brazil does, its NRCA values have only some degree of competitiveness. The mean for 2013–2022 suggests that Thailand's competitiveness is quite strong but only in a narrow comparison, with some selected comparative advantages in focused categories rather than a broad-based advantage. China consistently appears in all categories but is not competitive, as evidenced by its low export shares and negative NRCA values over the years. In commodities such as HS 1703 (molasses) and HS 1704 (sugar confectionery), where export shares are negligible for China, the NRCA values regularly fall below 0, revealing little expertise or ability to wield a competitive advantage through these goods.

Pakistan's role as an essential exporter of HS 1701 (table sugar) is unstable. However, the country maintains a high comparative advantage in HS 1702 (other sugars), HS 1703 (molasses), HS 1704 (sugar confectionery), and HS 2207 (ethyl alcohol). Even when Pakistan obtained some of its highest NRCA values in some products, such as HS 1703 (molasses), HS

1704 (sugar confectionery), and HS 2207 (ethyl alcohol), the relative share of the country in exports was low.

Brazil emerged as the most competitive country in sugar and ethyl alcohol exports from 2013 to 2022, having high export shares and consistently strong NRCA values in many categories. We find that Pakistan demonstrated low export shares but high NRCA values across multiple categories, indicating intense but short-lived competitiveness. Selective categories in India and Thailand also demonstrate moderate evidence of sustained competitiveness. China remained a medium-sized player and a more generalist trader, reflecting barriers to secure a comparative advantage relative to other major global competitors.

5. Discussion

An analysis of Pakistan's sugar industry products using the NRCA index yields important insights into the country's product-specific comparative advantage of the country relative to major global cane sugar producers. Pakistan demonstrated a better comparative advantage in many product categories, including HS 1702 (other sugars), HS 1703 (molasses), HS 1704 (sugar confectionery), and HS 2207 (ethyl alcohol). Thus, Pakistan has a lower opportunity cost in producing these categories of sugar products. However, its export shares are relatively low in almost all categories, raising questions about the performance of the country's industry. In broader categories, particularly HS 1701 (table sugar), remains weak, which is induced by export restrictions on HS 1701 (table sugar). Despite its low market shares, Pakistan's high comparative advantage indicates the opportunity for it to capitalize on the international market, particularly when it is facing a significant trade deficit and looking for export opportunities to earn foreign exchange earnings.

A comparison of Pakistan's NRCA performance with that of the leading cane sugar producing countries highlights the strength of Pakistan in its global competitiveness in sugar industry products. Notably, Brazil has consistently achieved the highest NRCA values in HS 1701 (table sugar) and HS 2207 (ethyl alcohol) due to its aggressive and unrestricted export policies, economies of scale, and advanced production technology. Meanwhile, from 2013 to 2022, Pakistan's NRCA for HS 1701 (table sugar) was negative in most years and only mildly positive in a few years. Banerjee (2005) pointed out that countries such as Brazil benefit from subsidies, mechanized agriculture, and well-established supply chains to compete on a different level than other less privileged exporters. Conversely, Pakistan's export policies have discouraged the export of table sugar, making it less competitive in this category.

Regarding HS 1702 (other sugars), Pakistan performs better than Brazil and India, according to the NRCA values, but still holds only a small export share. This result indicates the potential to produce niche domestic sugar products that require specific processing. Nonetheless, the country continues to trail behind Thailand and China in capitalizing on the

demand for refined sugar by-products, due to their superior processing capacities and greater access to global markets. These disparities are generally related to the limited value added in developing countries, such as Pakistan, where the emphasis is on primary products instead of pursuing high-value exports (Govındasamy et al., 2024). To address this gap, Pakistan should invest in modern sugar processing facilities and encourage the production of high-value sugar derivatives.

The NRCA analysis of HS 1703 (molasses) reflects Pakistan's structural strength compared with Brazil and China, particularly in recent years. Molasses is a by-product of sugar and the main ingredient in candies, animal feed, and ethyl alcohol production. Pakistan not only had a positive NRCA but also maintained a decent share of exports. However, the performance of India and Thailand is better than Pakistan. The findings of this study are consistent with those of Ahmad et al. (2024), who noted that although agro-based industries in Pakistan have great potential, they constantly underperform because of inconsistent policies and a lack of cooperation among stakeholders at multiple levels.

Pakistan's performance in HS 1704 (sugar confectionery and beverages) indicates low export shares but a high comparative advantage over the major cane sugar–producing countries. This category is particularly important as it serves consumer-oriented markets, which are expanding because of rising incomes and urbanization. China continuously maintained high market shares but had a negative NRCA, whereas Brazil and Thailand had a positive NRCA and higher shares compared with Pakistan. These countries have effectively leveraged branding, marketing, and quality control to capture this segment. Pakistan suffers from branding because of poor brand awareness and promotion for exports. To address this, Pakistan must develop targeted strategies to promote its confectionery products by focusing on niche markets and leveraging its competitive cost advantage.

The analysis of HS 2207 (ethyl alcohol) presents a comparatively better picture for Pakistan, having a relatively high positive NRCA and export share. Ethyl alcohol is a value-added product that is produced from molasses or the fermentation of sugar. It is increasingly demanded globally for biofuels and drinks production, as well as for industrial purposes. Pakistan's NRCA and market shares for ethyl alcohol surpass those of China and India and experience consistent growth. Brazil remains the global leader due to its longstanding ethyl alcohol program, which is supported by generations of government investment and trade considerations. The real challenge for Pakistan is to scale up ethyl alcohol production and expand its export base to include emerging markets for biofuels and green energy that are rapidly maturing worldwide. Blending ethyl alcohol with fuel for vehicles can reduce the bill on oil imports and save billions of dollars every year.

The results do not align entirely with all the findings of previous studies. Manzoor et al. (2023) highlighted that the sugar industry in Pakistan faces numerous challenges related

to its production and distribution inefficiencies, which are associated with higher costs and lower export competitiveness. This study confirms these findings for HS 1701 (table sugar), where Pakistan has negative NRCA values, indicating a lack of comparative advantage globally. Similarly, the results on HS 1702 and HS 1703 are consistent with previous studies, in which Pakistan is identified to be competitive in niche products but has much room for improvement to capture higher shares in the market. However, the analysis diverges from previous assessments of HS 2207 by revealing that among its reported in HS 2207, Pakistan had an overall better score.

Although Pakistan has a degree of comparative advantage in HS 1702, HS 1703, and HS 2207, it is still significantly behind the exporting leaders in terms of market share. Thus, the findings underscore the need for a holistic strategy and integration of the sugar industry to improve the country's competitiveness, with a focus on modernization, value addition, and product diversification, as well as improved structural efficiencies and alignment with international market systems.

6. Conclusion

An analysis of Pakistan's sugar industry using the NRCA index reveals the country's mixed performance in the global market. The country demonstrates comparative advantages in specific product categories, including HS 1702 (other sugars), HS 1703 (molasses), HS 1704 (sugar confectionery), and HS 2207 (ethyl alcohol), while its competitiveness in the primary category of HS 1701 (table sugar) remains weak. The combination of low export shares for many sugar product categories and its high comparative advantage indicates weak marketing strategies and policies for export enhancement. Its high comparative advantage indicates that it has an opportunity in the international market to capitalize on its potential to gain higher shares. One of the most significant opportunities is to position Pakistan to leverage sugar by-products (particularly in ethyl alcohol), as its performance indicates stable growth and good NRCA values. These developments represent a diversification opportunity for the sugar industry because of the expanding global demand for biofuels and industrial applications. However, poor performance in competing in niche markets characterized by HS1704 (sugar confectionery) and exports of primary sugar below the recorded demand means that value-adding opportunities are largely being missed.

These findings suggest that the opportunities for Pakistan's sugar industry to attain much greater performance in terms of competitiveness across the full range of products exist if a series of targeted and concerted policies are implemented. The country can strengthen its position in the global market by aligning its strengths around some of its by-products, such as ethyl alcohol, and addressing weaknesses in the export of primary sugar. For sustainable industry growth, policymakers must prioritize modernization, value addition, and market diversification. Pakistan's sugar industry has significant gaps in policy, technology,

and supply chain compared to those of global competitors. Leading exporters place their production closer to their consumers to integrate value chains, with strong exporters benefiting from government incentives (e.g., Brazil, Thailand, and India) and technological innovations, leading to cost reduction and an increase in productivity. In contrast, Pakistan necessitates investments in modernizing its domestic sugar industry, encouraging public–private partnerships, and tackling high production costs.

The study contributes to the existing literature and policy direction by providing a product-level assessment of performance, competitiveness, and comparative advantages for major cane sugar producing countries.

Notes:

i The figures were calculated by the authors based on the ITC's trade map data.

ii HS 1701: Cane or beet sugar and chemically pure sucrose, in solid form (table sugar); HS 1702: Other sugars, including chemically pure lactose, maltose, glucose, and fructose, in solid form (other sugars); HS1703: Molasses resulting from the extraction or refining of sugar (molasses); HS 1704: Sugar confectionery not containing cocoa, including white chocolate (sugar confectionery); and HS 2207: Undenatured ethyl alcohol with an alcoholic strength of ≥80%, ethyl alcohol, and other spirits (ethyl alcohol).

iii Adopted from the study by Ashadullah (2021).

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