Turkish Journal of Engineering

https://dergipark.org.tr/en/pub/tuje

e-ISSN 2587-1366

Analyzing global competitiveness of Turkish air conditioning industry

Fatma İzgi [1], **Mustafa Kavacık** [*2]

[1] *Bayburt University, Department of International Trade and Business, Türkiye, fatmaizgi@bayburt.edu.tr*
[2] *Necmettin Erbakan University, Department of International Trade and Finance, Türkiye, mustafa.kavacik@erbakan.edu.tr*

Cite this study: İzgi, F., & Kavacık, M. (2024). Analyzing global competitiveness of Turkish air conditioning industry. Turkish Journal of Engineering, 8 (2), 209-234

https://doi.org/10.31127/tuje.1372141

Keywords
Global competitiveness
Air conditioning
Comparative advantages
Product mapping
Türkiye

Research Article

Received: 06.10.2023
Revised: 07.12.2023
Accepted: 10.12.2023
Published: 08.04.2024

Abstract

The global economy significantly relies on the air conditioning sector, which has been gaining increased importance worldwide and in Türkiye due to the impact of global warming, climate change, and the diminishing energy resources. As a multifaceted industry encompassing air conditioning, heating, installation, insulation, refrigeration and ventilation sector has been adapting to the growing demand for environmentally friendly and energy-efficient solutions. This study analyzes air conditioning industry of Türkiye and its sub-product groups in terms of its ability to compete internationally, spanning from 2001 to 2021. To assess competitiveness, we employed various analytical tools, including Balassa's Revealed Comparative Advantages Index (RCA), Vollrath Indices (RXA, RMP, RTA, RC), Revealed Symmetric Comparative Advantages Index (RSCA), Trade Balance Index (TBI), and Product Mapping method. Notably, there is no research that scrutinize the competitiveness of the Turkish air conditioning industry utilizing the Product Mapping. The study findings emphasize that air conditioning industry of Türkiye has competitiveness. Within the sub-product group, the analysis reveals that Türkiye has competitiveness for 11 products, a near-limit competitiveness for 3 products, and a lack of competitiveness for 10 products.

1. Introduction

Recently, due to globalization, information and technological developments, the nature of competition has altered radically. The most significant actor in the growth and development of the country's economy is international trade. Export plays a crucial role in reducing the dependence of enterprises on the domestic market and increasing their competitiveness. In short, the existence of competitiveness in a country and the existence of stability on a macroeconomic scale depend on qualified workforce, an effectively functioning market order and the existence of a developed commercial infrastructure. Stigler [1] clarified the concept of competition as "*the competitive activity of two or more people*". While Classical Economists put forward the concept of competition as a dynamic structure, Neo-Classical Economists analyzed the concept of competition with static equilibrium under perfect competition conditions. Jevon mentioned the significance of the concept of competition as follows: "*If there is no competition between economic agents and workers, there is little, or even nothing, that economics can do.*" [2]. Some academics have enlightened the determinants of competitiveness. Adam Smith [3], as absolute cost advantage, Ricardo [4], as comparative cost advantage, Eli Heckscher and Bertil Ohlin [5]as factor endowment, Kenen [6] and Keesing [7], as skilled labor force, Posner [8], as technology innovation, Vernon [9], Krugman [10], Grossman and Helpman [11] and Lai [12], technological innovations, development of new products, as activities of multinational companies, Porter [13], at high level and as a constantly increasing productivity, Moon et al., [14], as the interaction between local diamonds and global diamonds, Cho [15], as the ability of human factors to use physical factors effectively, Aiginger [16], as the ability to create wealth, Cho, Moo and Young [17] explained it as the interaction of local and international factors and the opening of human factors to inter-country circulation .

The world has entered a transition process with the transition from the 20th century to the 21st century. The main effects of this process on the world have been realized as global warming and environmental effects. In this process of alteration, the need for the air conditioning sector to provide comfortable living conditions is gradually booming. In addition, factors such as the growth of the construction industry, climate

change and increasing consumer tendency towards comfort have also increased the demand for the air conditioning sector. Sub-product groups such as heating, cooling, ventilation and air conditioning systems and equipment are in high demand by consumers owing to increasing temperatures every year, cold winters, and unpredictable climatic conditions. During the Covid-19 pandemic, the demand for ventilation systems in the sector has increased and its significance has been recognized. These factors reveal that the air conditioning industry will be an indispensable part of the future and will be an industry that increases its importance day by day. Therefore, these enhanced the focus of the study.

The air conditioning sector is one of the most significant export items of the machinery-manufacturing sector. Türkiye has become an important player in the air conditioning sector, meeting the rapidly developing domestic demand, both in an intensely competitive environment and with increasing exports in international markets. This air conditioning sector rises its added value with engineering and design services.

This study analyzes air conditioning industry of Türkiye and its sub-product groups in terms of its ability to compete internationally, spanning from 2001 to 2021. In this regard, Balassa's Revealed Comparative Advantage Index (RCA), Vollrath Indices (RXA, RMP, RTA, RC), Revealed Symmetric Comparative Advantage Index (RSCA), Trade Balance Index (TBI) and Product Mapping were used in this study. There was no study, which was conducted to analyze air conditioning industry of Türkiye in terms of global competitiveness.

Studies in the literature within the scope of the air conditioning industry are generally related to the field of engineering. Since the number of studies in the literature is very limited in terms of evaluating the place of the air conditioning industry in international competitiveness, both nationally and internationally, it is supposed that this study will contribute to the literature and be important as a reference source for future research.

This study is essentially divided into four sections. After the introduction section, the foreign trade situation of the air conditioning sector is mentioned. Subsequently, studies using both the Air Conditioning sector and product mapping method were included in the literature review section. In the methodology section, the indices used are explained in detail. In the results, global competitiveness of the air conditioning industry and sub-products are analyzed. Assessment of the index results and recommendations for the sector are involved in the conclusion section.

2. Foreign trade of the air conditioning sector

The demand for the air conditioning sector is rising with increasing global disposable incomes and the growth of the construction industry. The air conditioning sector is a sector that is increasingly gaining importance in the global economy. Table 1 lists the exporting countries of the global air conditioning industry for the 2020-2022 periods. It was recorded as 477 billion dollars in 2020. In 2021, total air conditioning exports increased compared to 2020 and reached 567 billion dollars. In 2022, total air conditioning exports were 559 billion dollars. China ranks first in the world in air conditioning exports. Then, countries such as Germany, USA, Italy, Japan, Mexico, France, Netherlands, Korea, United Kingdom and Thailand come next. China's air conditioning exports 95 billion dollars of air conditioning exports in 2020, 120 billion dollars of air conditioning exports in 2021 and 123 billion dollars of air conditioning exports in 2022.

According to Table 1, Germany's total air conditioning exports in 2020, which ranks second in world air conditioning exports, were 63 billion dollars, 73 billion dollars in 2021 and 65 billion dollars in 2022. The USA, which ranks third in the world in terms of air conditioning, realized air conditioning exports of 46 billion dollars in 2020, air conditioning exports of 51 billion dollars in 2021 and air conditioning exports of 54 billion dollars in 2022. Ranking fourth in global air conditioning exports, Italy's total air conditioning exports in 2020 were recorded as 29 billion dollars, total air conditioning exports in 2021 were recorded as 36 billion dollars and in 2022 were recorded as 34 billion dollars. Ranking fifth in global air conditioning exports, Japan's total air conditioning exports in 2020 were 19 billion dollars, its total air conditioning exports in 2021 were 23 billion dollars and its total air conditioning exports in 2022 were 21 billion dollars.

According to the data in the Table 1, Türkiye ranks 19th in global air conditioning exports and its global air conditioning export share is 3%. Türkiye's air conditioning exports have increased gradually in the 2017-2021 periods.

When the export data of the sub-product groups of the world air conditioning industry is examined, the total exports of the heating sub-product group in 2021 are 41 billion dollars, the total exports of the refrigeration sub-product group in 2021 are 65 billion dollars, the total exports of the air conditioning sub-product group in 2021 are 86 billion dollars, The total exports installation of the year 2021 were 253 billion dollars, the total exports of the ventilation sub-product group in 2021 were 110 billion dollars, and the total exports of the insulation sub-product group in 2021 were 10 billion dollars [18].

Global air conditioning sector imports are increasing. Table 2 demonstrates the data of the air conditioning importing countries spanning from 2020 to 2022. Therefore, in 2020, global air conditioning imports were documented as 487 billion dollars, 575 billion dollars in 2021, and 574 billion dollars in 2022. The USA ranks first in global air conditioning imports. Subsequently, there are respectively. countries such as Germany, China, France, Mexico, Canada, the United Kingdom, Japan, Italy, the Netherlands and Russia.

According to Table 2, total air conditioning imports of the USA in 2020 were 69 billion dollars, total air conditioning imports were 85 billion dollars in 2021 and total air conditioning imports were 93 billion dollars in 2022. Germany, which ranks second in global air conditioning imports, reached total air conditioning imports of 36 billion dollars in 2020, total air conditioning imports of 44 billion dollars in 2021 and total air conditioning imports of 41 billion dollars in 2022. China, which ranks third in global air conditioning

imports, imported 33 billion dollars of air conditioning in 2020, 39 billion dollars of air conditioning in 2021 and 35 billion dollars of air conditioning in 2022. The total air conditioning imports of France, which ranks fourth in global air conditioning imports, in 2020 was 18 billion dollars, the total air conditioning imports in 2021 were 22 billion dollars and in 2022 was 21 billion dollars. Mexico, which ranks fifth in global air conditioning imports, imported 15 billion dollars of air conditioning in 2020, 19 billion dollars of air conditioning in 2021 and 22 billion dollars of air conditioning.

According to the data in the Table 2, Türkiye ranks 20th in global air conditioning imports and its global air conditioning import share is 2%.

Table 1. World air conditioning industry export (Compiled by authors via ITC Trademap data).

Exporters	2020	2021	2022
World	477.642.745	567.735.063	559.596.561
China	95.290.278	120.494.105	123.805.987
Germany	63.575.524	73.374.642	65.771.003
USA	46.624.978	51.346.563	54.834.214
Italy	29.873.559	36.035.958	34.595.083
Japan	19.610.597	23.208.215	21.668.148
Mexico	18.051.974	20.688.738	23.881.755
France	14.946.513	16.911.924	16.112.124
Netherlands	12.906.944	14.898.799	12.959.485
Korea,	13.561.678	14.714.788	15.206.907
United Kingdom	12.728.606	14.404.137	14.322.954
Thailand	9.989.726	12.341.700	12.810.852
Belgium	9.347.350	11.387.127	11.024.615
Czech Republic	9.061.103	10.666.216	9.883.389
Poland	7.826.820	10.059.651	12.30.036
Austria	6.208.927	7.864.945	8.011.061
Switzerland	6.678.192	7.776.167	8.235.981
Canada	6.797.228	7.596.966	8.531.084
Spain	6.235.812	7.553.296	7.591.763
Türkiye	5.203.415	6.888.041	6.680.529

Table 2. World's air conditioning industry import (Compiled by authors by means of ITC Trademap data).

Importers	2020	2021	2022
World	487.090.330	575.967.053	574.725.445
USA	69.115.048	85.178.949	93.232.958
Germany	36.636.764	44.809.202	41.443.862
China	33.294.351	39.694.804	35.114.283
France	18.318.730	22.724.032	21.772.437
Mexico	15.593.475	19.009.295	22.221.526
Canada	15.657.401	18.512.257	20.880.250
United Kingdom	14.102.445	17.140.853	18.342.043
Japan	13.996.775	16.204.937	15.541.302
Italy	12.037.165	15.662.571	16.673.763
Netherlands	11.864.569	14.490.527	13.807.740
Russia	11.529.097	14.115.285	8.830.917
Korea	11.592.483	12.669.891	13.061.176
Poland	9.046.610	11.561.800	11.748.406
Spain	9.204.822	11.074.372	10.844.016
Belgium	8.678.978	10.977.947	10.315.411
India	7.638.821	9.804.226	9.574.173
Czech Republic	6.994.500	8.600.555	7.977.232
Thailand	6.499.229	8.074.522	8.101.439
Australia	6.756.441	7.965.329	8.487.309
Türkiye	6.555.121	7.836.864	7.199. 606

When the import data of the sub-product groups of the world air conditioning industry is examined, the total imports of the heating sub-product group in 2021 are 41 billion dollars, the total imports of the refrigeration sub-product group in 2021 are 67 billion dollars, the total imports of the air conditioning sub-product group in 2021 are 86 billion dollars, the total imports of installation the year 2021 were 258 billion dollars, the total imports of the ventilation sub-product group in 2021 were 111 billion dollars, and the total imports of the insulation sub-product group in 2021 were 10 billion dollars [18].

Türkiye's air conditioning exports are gradually increasing in the periods between 2017-2022. Türkiye's air conditioning export and import data for the 2012-2022 periods are demonstrated in Figure 1. Türkiye's total air conditioning exports in 2012 were 3 billion dollars, total air conditioning exports were 4 billion dollars in 2013, total air conditioning exports were 4 billion dollars in 2014, total air conditioning exports were 3 billion dollars in 2015, total air conditioning exports were 3 billion dollars in 2016, air conditioning exports are 4 billion dollars in 2017, total air conditioning exports are 4 billion dollars in 2018, total

air conditioning exports are 5 billion dollars in 2019, total air conditioning exports are 5 billion dollars in 2020, total air conditioning exports are 6 billion dollars in 2021 and total air conditioning exports are 6 billion dollars in 2022. The countries to which Türkiye exports air conditioning are respectively Germany, the United Kingdom, Italy, France, Iraq, Russia, Spain and Romania [18].

Türkiye's total air conditioning imports in 2012 were 5 billion dollars, total air conditioning imports were 7 billion dollars in 2013, total air conditioning imports were 6 billion dollars in 2014, total air conditioning imports were 6 billion dollars in 2015, total air conditioning imports were 6 billion dollars in 2016, total air conditioning imports were 6 billion dollars in 2017, total air conditioning imports are 6 billion dollars in 2018, total air conditioning imports are 5 billion dollars in 2019, total air conditioning imports are 6 billion dollars in 2020, total air conditioning imports are 7 billion dollars in 2021 and total air conditioning imports are 7 billion dollars in 2022. The countries from which Türkiye imports air conditioning are respectively China, Germany, Italy, USA, France, Czech Republic, Korea, Poland, Thailand, United Kingdom, and Japan [18].

Figure 1. Türkiye's air conditioning export and import (Compiled by authors via ITC Trademap).

3. Literature review

There are many studies in the literature on national competitiveness analysis for sectors and sub-sectors both in the world and in our country. Generally, in Türkiye's air conditioning sector reports, a section is separated for competitive analysis and competitive analysis is made by means of Porter's diamond model. In the literature review, it was determined that there is no study analyzing the exports and imports of the Turkish Air Conditioning sector and examining the international competitiveness of the sector within the temporal cycle (2001-2021). It is considered that this study will contribute to the literature in filling this gap. This study contributes to the literature in terms of enabling detailed global competitiveness analysis of Türkiye's air conditioning industry and sub-products by means of various indices and addressing the product mapping for the first time.

There are studies in the literature within the scope of the air conditioning sector. These; Lehtonen and Sipilä [19], in the study, both sector analysis and competition analysis were conducted by making phone calls to Air Conditioning (HVAC) companies. It was emphasized that the air conditioning sector will change and grow significantly in recent years. Srikandi et al., [20], conducted a comparative analysis of HVACR company (Daikin and Carrier) and used strategic management approach in the analysis. Isaac & Vuuren [21], analyzed the potential development and changes in future energy use for air conditioning and residential heating in the context of climate change. In the study, it is highlighted that energy demand for air conditioning will increase rapidly in the 21st century. Visintin & Rapaccini [22] examined the relationship between higher levels of service provision and better financial performance of companies operating in the HVAC sector in Italy (250 companies). The study offers findings that service provision has an impact on company profitability. Acül [23], in this study, the general situation of the Turkish air conditioning and installation sector and the developments in foreign trade were reflected, and the R&D infrastructure of the sector was examined. Emphasis is placed on the efficient and versatile structuring of SME R&D departments in the air conditioning and installation sector, and a management model has been proposed on how to use resources effectively. Ors and Yumus [24] determined the determinants of the competitiveness of the air conditioning sector in the study and the interview method was used in the study. According to the findings of this study, demand conditions, general production infrastructure of the sector, access to raw materials and semi-finished products, legal regulation related to the sector, volatility in financial markets including exchange rates, determinants such as foreign political relations, and engineering quality have been revealed. Erturan [25], in this study, the development and performance of the financial structure of the air conditioning sector was examined through financial analysis techniques.

Generally, studies in the literature on measuring international competitiveness use Balassa's index and Vollrath indexes. Turkish literature using the product mapping method is extremely limited [26-32]. Topçu and Sarıgül [26] analyzed the competitiveness of the five sectors with the highest share in Türkiye's exports (textile, clothing, iron and steel, electrical machinery, motor vehicles) for the period 2000-2014. Bashimov and Aydın [27] examined the competitiveness of the aquaculture sector of the Baltic countries (Estonia, Lithuania, Latvia) for the periods 2001-2015 and determined the place of the relevant sector in foreign trade by means of the product mapping. Bakkalcı [28] investigated the competitiveness of the Turkish automotive industry for the period 1995-2016 and determined its place in foreign trade as using the product mapping. Bakkalcı [29] analyzed the competitiveness of Türkiye's textile industry within the framework of the period 2001-2016 and applied the product mapping method. Keskingöz [30] examined the competitiveness of 24-chapters belonging to Türkiye's agricultural sector for the period 2001-2017 and revealed which chapters had comparative advantage. Yeldan et al., [31] evaluated the competitiveness of the Turkish iron and steel sector for the periods 2001-2017 and used the product mapping to determine the sector's place in foreign trade. Başkol and Bektaş [32] analyzed the competitiveness of the Turkish iron-steel industry in the periods covering the years 2000-2019 and examined specifically in nine with three-digit sub-sectors.

Studies in the international literature on product mapping method are [33-39]. Ischukova and Smutka [33] investigated the structure of Russian foreign trade in agricultural products for the period of 1998-2010 in terms of specialization and competitive performance. Astaneh et al., [34] examined the competitiveness of Iran's stone fruit exports spanning from 1997 to 2010 and determined the target market for Iran's stone fruit exports. Ischukova and Smutka [35] scanned the competitive performance of Russia's agricultural and food exports and compared with special regions (Asia, Africa, America, Commonwealth of Independent States, European Union countries). Pawlak [36] determined the level and changes in the comparative advantages of Poland's agricultural-food sector in the US markets for the period of 2001-2017. Saeyang and Nissapa [37] analyzed the competitiveness of Indonesia, Malaysia and Thailand in the four-palm oil world market trade for the period of 2001-2017. Tandra et al., [38] examined the international competitiveness of palm oil exporters of countries in the world for the period of 1996-2019. Saxena et al., [39] mapped comparative advantage and trade balance of India's horticultural products (HS-6 Digit 40 products). In addition, seasonality advantage and export potential were revealed.

4. Data sources and methodology

4.1. Data Sources

Export and import data used in this study were taken from the TradeMap. In the study, HS Code of the air conditioning industry and sub-products (air conditioning, heating, installation, insulation, refrigeration and ventilation) were determined within the scope of the Customs Tariff Statistics Position. HS Code for the air conditioning sector, whose international competitiveness was analyzed within the scope of the study, are demonstrated in Table 3. Export and import data regarding Türkiye's air conditioning sector were analyzed and competitiveness was evaluated within the framework of the 2001-2021 periods.

4.2. Methodology

International competitiveness indices available in the literature were used as methodology in the study. In this context, the indices used in the study and applied to measure international competitiveness are as follows:

Bela Balassa developed the Revealed Comparative Advantage (RCA) index in 1965. It is a frequently used measure to compare relative advantages in export performance by country and sectors [40]. This index is calculated by calculating the ratio of the country's exports in that sector to its total exports and then dividing the world's exports of the same sector to its total exports. The formula used to calculate the Revealed Comparative Advantage (RCA) index is shown in Equation 1:

$$RCA = \frac{X_{kt}^{j} / X_{t}^{j}}{X_{kt}^{w} / X_{t}^{w}} \quad (1)$$

In Equation 1, 'j' represents the country, 't' represents the period, 'k' represents the product or sector, and 'w' represents the world country groups. If the RCA value is less than 1, the country is at a disadvantage in terms of comparative advantages revealed in the relevant goods or sector group, and when the value is greater than 1, the country has comparative advantage in the relevant goods and sector group [41].

Vollrath [42], who criticized the Balassa Index for only taking exports into account, identified the deficiencies in Balassa's RCA and developed several new indices as an alternative to this index. Unlike the Balassa Index, Vollrath prevented double counting of the country's data by subtracting the export data of the examined sector from the total exports [43]. Vollrath [42] developed the Relative Export Advantage index (RXA), Relative Import Index (RMP), Relative Trade Advantage Index (RTA) and Revealed Competitiveness Index (RC).

Relative Export Advantage Index (RXA) is calculated by means of export data, as in the Revealed Comparative Advantage Index. This index, unlike the Balassa index, prevents double counting of the country and sector. The index is defined as the ratio of a country's export share of a certain sector or product in the world market to the same country's share in world exports of all other sectors or products [44]. The formula used to calculate the Relative Export Advantage Index (RXA) is shown in Equation 2:

$$RXA = (X_{ij} / \sum_{l,l\neq j} X_{il}) / \sum_{k,k\neq j} X_{kj} / \sum_{k,k\neq i} \sum_{l,l\neq j} X_{kl}) \quad (2)$$

Table 3. HS Codes of sub-product groups of the air conditioning sector "HVAC-R Exporters Association (ISIB).

Sub-product groups of the air conditioning sector	Hs Code	Production Description
Heating	732181	Stoves, heaters, grates, fires, wash boilers, braziers and similar appliances, of iron or steel, for gas fuel or for both gas and other fuels (excl. cooking appliances, whether or not with oven, separate ovens, plate warmers, central heating boilers, geysers and hot water cylinders and large cooking appliances)
	732211	Radiators for central heating, non-electrically heated, and parts thereof, of iron or steel (excl. parts, elsewhere specified or included, and central-heating boilers)
	840220	Superheated water boilers
	840310	Central heating boilers, non-electric (excl. vapor generating boilers and superheated water boilers of heading 8402)
	840410	Auxiliary plant for use with boilers of heading 8402 or 8403, e.g. economizers, superheaters, soot removers and gas recoverees;
	841610	Furnace burners for liquid fuel
	841939	Dryers (excl. lyophilization apparatus, freeze drying units, spray dryers, dryers for agricultural products, for wood, paper pulp, paper or paperboard, for yarns, fabrics and other textile products, dryers for bottles or other containers, hairdryers, hand dryers and domestic appliances)
	851610	Electric instantaneous or storage water heaters and immersion heaters
Refrigeration	841891	Furniture designed to receive refrigerating or freezing equipment
	841490	Parts of: air or vacuum pumps, air or other gas compressors, fans and ventilating or recycling hoods incorporating a fan, and gas-tight biological safety cabinets, n.e.s.
	841850	Furniture "chests, cabinets, display counters, show-cases and the like" for storage and display, incorporating refrigerating or freezing equipment (excl. combined refrigerator-freezers with separate external doors, household refrigerators and freezers of the chest type of a capacity <= 800 l or of the upright type of a capacity <= 900 l)
	841989	Machinery, plant or laboratory equipment, whether or not electrically heated, for the treatment of materials by a process involving a change of temperature such as heating, cooking, roasting, sterilizing, pasteurizing, steaming, evaporating, vaporizing, condensing or cooling, n.e.s. (excl. machinery used for domestic purposes and furnaces, ovens and other equipment of heading 8514)
Air Conditioning	841430	Compressors for refrigerating equipment
	841520	Air conditioning machines of a kind used for persons, in motor vehicles
Ventilation	830710	Flexible tubing of iron or steel, with or without fittings
	841460	Hoods incorporating a fan, whether or not fitted with filters, having a maximum horizontal side <= 120 cm
Istallation	391731	Flexible tubes, pipes and hoses, of plastics, burst pressure >= 27,6 MPa
	392111	Plates, sheets, film, foil and strip, of cellular polymers of styrene, unworked or merely surface-worked or merely cut into squares or rectangles (excl. self-adhesive products, floor, wall and ceiling coverings of heading 3918 and sterile surgical or dental adhesion barriers of subheading 3006.10.30
	741220	Copper alloy tube or pipe fittings "e.g., couplings, elbows, sleeves"
	902511	Thermometers, liquid-filled, for direct reading, not combined with other instruments
	902610	Instruments and apparatus for measuring or checking the flow or level of liquids (excl. meters and regulators)
Insulation	400819	Rods and profile shapes, of cellular rubber
	680610	Slag-wool, rock-wool and similar mineral wools, incl. intermixtures thereof, in bulk, sheets or rolls
	701939	Webs, mattresses, boards and similar nonwoven products, of glass fibres (excluding mats and thin sheets "voiles")

In Equation 2, X is export and I and k indices are product categories; j and l represent countries. If the value of RXA is greater than 1, it has a competitive advantage in products and sectors; if it is less than 1, it has a competitive disadvantage in products and sectors [45].

The Relative Import Penetration Index (RMP), unlike the Relative Export Advantage Index, is calculated by means of import data. The difference between RMP and RXA indices is that the formula is grounded on import data as opposed to export data [44]. Imports (M) are involved in the equation instead of exports. The formula used to calculate the Relative Import Penetration Index (RMP) is shown in Equation 3:

$$RMP = (M_{ij} / \sum_{l,l\neq j} M_{il}) \Big/ (\sum_{k,k\neq i} M_{kj} / \sum_{k,k\neq i} \sum_{l,l\neq j} M_{kl}) \quad (3)$$

If the RMP index value is greater than 1, it points out a competitive disadvantage in the product or sector, and if it is less than 1, it points out a competitive advantage in the product or sector [46].

Relative Trade Advantage Index (RTA) is consisted of by considering the differences between the Relative Export Advantage Index and the Relative Import Penetration Index. This index takes both export and import aspects into account, therefore it will offer more accurate results in calculating competitiveness. If the RTA index is positive, it indicates that it has competitive power in the sector and product group, and if the RTA index is negative, it indicates that it does not have competitive power or does not have an advantage in the sector and product group [44]. The formula used to calculate the Relative Trade Advantage Index is shown in Equation 4:

$$RTA = RXA_{ij} - RMP_{ij} \quad (4)$$

Vollrath [42] developed the Revealed Competitive Advantage Index (RC). This index is calculated by considering the logarithm of the difference between the Relative Export Advantage Index (RXA) and the Relative Import Penetration Index (RMP). It is revealed that if the RC index value is positive, it has a comparative competitive advantage in the sector or product group, and if the RC index has negative values, it does not have a comparative advantage in the relevant sector and product group [46]. The formula used to calculate the Revealed Competitive Advantage Index (RC) is shown in Equation 5:

$$RC_{ij} = ln(RXA_{ij}) - ln(RMP_{ij}) \quad (5)$$

In this formula, RC_{ij} is the Relative Competitive Advantage Index of country j in product or sector i; RXAij demonstrates The Relative Export Advantage Index of country j in product i or sector, RMP_{ij} demonstrates The Relative Import Penetration Index of country j in product i or sector. According to Vollrath [42], the Revealed Competitive advantage index (RC) is a more preferable measurement than RXA and RTA since it displays better the supply and demand index [45].

The Revealed Symmetric Comparative Advantage Index (RSCA), Laursen [47], if the export value of any product or sector is 0, the asymmetry problem arises and this problem affects the evaluation of the analysis. Hence, the RCA index requirements to be adjusted symmetrically within its neutral value. Dalum, Laursen and Villumsen [48] recommended the Revealed Symmetric Comparative Advantage Index for corrections. Laursen suggested the Equation 6 to make the RCA index symmetrical [47]:

$$RSCA = \frac{RCA - 1}{RCA + 1} \quad (6)$$

The values of the Revealed Symmetric Comparative Advantage Index (RSCA) diverge between ''-1 or +1''. If RSCA>0, it indicates that the relevant country has a comparative advantage in the product or sector. Otherwise, if RSCA<0, it indicates that the relevant country has a comparative disadvantage in the product or sector [50].

Trade Balance Index (TBI) was developed by Lafay [49] and is recognized as the Lafay index in the literature. This index shows whether the relevant country is a net exporter or net importer of the sector or product. The formula used to calculate the Trade Balance Index is shown in Equation 7:

$$TBI_{TRairconditioning}: \frac{(E_{TRairconditioning} - M_{TRairconditioning})}{(E_{TRairconditioning} + M_{TRairconditioning})} \quad (7)$$

In Equation 7, " $E_{TRairconditioning}$" represents Türkiye's air conditioning sector exports. ''$M_{TRAirconditioning}$'' represents Türkiye's air conditioning industry imports. If the Trade Balance Index value is negative, it is called "net importer" in the relevant product or sector, and if it is positive, it is called "net exporter" in the relevant product or sector [50].

Widodo [50] developed Product Mapping method. The product map was generated by means of the Revealed Symmetric Comparative Advantage Index (RSCA) and the Trade Balance Index (TBI). In the sector examined, both the foreign trade balance and competitiveness of the country are evaluated together. Product mapping comprise of four different groups (A, B, C, D). Group A consists of products that have both comparative advantage and export specialization. Group B is one of the products that have a comparative advantage yet do not display specialization in exports; Group C contains of products that have specialization in exports however do not have a comparative advantage; Group D consists of products that do not have comparative advantage or specialization in exports (Table 4).

Table 4. Product mapping [50].

RSCA>0	Group B: Comparative Advantage Net-importer (RSCA>0 and TBI<0)	Group A: Comparative Advantage Net-exporter (RSCA>0 and TBI>0)
RSCA<0	Group D: Comparative Disadvantage Net-importer (RSCA<0 and TBI<0) TBI<0	Group C: Comparative Disadvantage Net-exporter (RSCA<0 and TBI>0) TBI>0

5. Results

Table 5 displays the global competitiveness analysis results of the air conditioning industry. The results differ depending on Türkiye's air conditioning exports and imports. RCA index results have fluctuated over certain periods and the average value of this index is calculated as 1.01. These index values are above 1 in the periods covering 2007-2014 and 2018-2021. In other periods, calculated values are less than 1. The average value of the RXA index calculated in the 2001-2021 periods was recorded as 1.04. RCA index results are parallel to RXA index results. When the results of these two indices are evaluated in general, results indicate that the air conditioning sector has competitiveness and shows specialization in exports. In order to the RMP index to have competitiveness in the relevant sector or product group, the calculated value need be below 1. RMP index results were found to be greater than 1 throughout the periods covered in the study, which reveals the excess imports of the relevant products. Since RTA and RC indices consider both export and import aspects into account, the calculated results will be objective. The values calculated for both indices in the 2008, 2010, 2011, 2012, 2014, 2019, 2020 and 2021 periods are positive. Therefore, it has been determined that it has a competitive advantage in the air conditioning sector in these periods. RSCA index, the average value calculated in the 2001-2021 periods is greater than zero, which demonstrates the comparative advantage of the relevant sector. However, the average value of the TBI index calculated in the 2001-2021 periods is less than zero, which indicates that these products are net-importers. In the 2001-2006 and 2015-2017 periods, the product mapping reveals that the air conditioning sector has a net- importer (Group D) with comparative disadvantage. In other periods, it has a comparative advantage of the relevant products but is net- importer (Group B). According to the product mapping method for the 2001-2021 periods, the average results were RSCA>0, TBI<0, therefore it was determined that Turkish Air Conditioning sector has a comparative advantage in trade however is a net-importer (Group B).

Table 5. International competitiveness analysis of the air conditioning industry (Compiled by authors).

Year	RCA	RXA	RMP	RTA	RC	RSCA	TBI	Product Mapping
2001	0,69	0,70	1,37	-0,67	-0,29	-0,18	-0,44	Group D-RSCA<0, TBI<0
2002	0,75	0,76	1,43	-0,66	-0,27	-0,14	-0,45	Group D-RSCA<0, TBI<0
2003	0,81	0,83	1,16	-0,33	-0,14	-0,10	-0,34	Group D-RSCA<0, TBI<0
2004	0,82	0,85	1,11	-0,26	-0,11	-0,09	-0,33	Group D-RSCA<0, TBI<0
2005	0,90	0,92	1,07	-0,14	-0,06	-0,05	-0,29	Group D-RSCA<0, TBI<0
2006	0,97	1,00	1,15	-0,15	-0,06	-0,01	-0,29	Group D-RSCA<0, TBI<0
2007	1,01	1,05	1,13	-0,08	-0,03	0,00	-0,25	Group B-RSCA>0, TBI<0
2008	1,06	1,09	1,09	0,00	0,00	0,02	-0,20	Group B-RSCA>0, TBI<0
2009	1,04	1,08	1,15	-0,06	-0,02	0,02	-0,18	Group B-RSCA>0, TBI<0
2010	1,16	1,20	1,05	0,14	0,05	0,07	-0,18	Group B-RSCA>0, TBI<0
2011	1,23	1,28	1,11	0,17	0,06	0,10	-0,21	Group B-RSCA>0, TBI<0
2012	1,11	1,15	1,11	0,03	0,01	0,05	-0,20	Group B-RSCA>0, TBI<0
2013	1,14	1,18	1,25	-0,06	-0,02	0,06	-0,26	Group B-RSCA>0, TBI<0
2014	1,12	1,17	1,04	0,12	0,04	0,06	-0,15	Group B-RSCA>0, TBI<0
2015	0,99	1,03	1,14	-0,11	-0,04	-0,00	-0,21	Group D-RSCA<0, TBI<0
2016	0,93	0,97	1,32	-0,35	-0,13	-0,03	-0,29	Group D-RSCA<0, TBI<0
2017	0,97	1,00	1,12	-0,12	-0,04	-0,01	-0,23	Group D-RSCA<0, TBI<0
2018	1,06	1,10	1,12	-0,02	-0,00	0,03	-0,12	Group B-RSCA>0, TBI<0
2019	1,09	1,13	1,09	0,04	0,01	0,04	-0,06	Group B-RSCA>0, TBI<0
2020	1,14	1,18	1,13	0,05	0,02	0,06	-0,11	Group B-RSCA>0, TBI<0
2021	1,19	1,25	1,17	0,07	0,02	0,09	-0,06	Group B-RSCA>0, TBI<0
Average	1,01	1,04	1,16	-0,11	-0,04	0,01	-0,23	Group B-RSCA>0, TBI<0

Table 6-8 demonstrate the international competitiveness analysis results for the Heating sub-product. When the RCA Index results calculated for the products (HS Code 732181, HS Code 732211 and HS Code 840310) were assessed in general, the values were found to be 1 and above. The average values of the index results were respectively calculated as 2.77, 26.34 and 6.93. The results of the RXA index are parallel to the results of the RCA index. Therefore, according to the index results, it has been determined that Türkiye has competitiveness in these three products and indicates specialization in exports. However, when the RCA index results calculated for the other three products (HS Code 840220, HS Code 841610 and HS Code 851610) are evaluated in general, it is realized that the values are 1 and below. The average values of the index results were respectively calculated as 0.13, 0.69 and 0.31. The results are similar to the RXA index. Therefore, according to the results of these two indexes, it has been revealed that Türkiye does not have competitiveness in these products and does not specialize in exports. When the results calculated for the products (HS Code 840410 and HS Code 841939) are examined, it has been determined that the competitiveness of these products is at the limit and it is comprehended from the latest index results that the competitiveness of these products will increase in the future. In order for the RMP Index to gain competitive advantage in the relevant sector or product group, the calculated values need to below one. The calculated RMP index results of the products (HS Code 732181, HS Code

732211) are below one, therefore the comparative advantage of these products emerges. The RMP index results calculated for the products (HS Code 840220, HS Code 840310, HS Code 840410, and HS Code 841939) are above one, thus revealing the import surplus of these products. In two non-competitive products (HS Code 841610 and HS Code 851610), the calculated RMP index values are below one, which indicates that the import of these products is low. Since RTA and RC indices consider both export and import aspects into account, the calculated results will be objective. When these index results are assessed in general, the values calculated for the products (HS Code 732181, HS Code 732211 and HS Code 840310) are positive. Therefore, it has been determined that these products have a competitive advantage. Although there are fluctuations in some periods, the calculated values for other products (HS Code 840220, HS Code 840310, HS Code 840410, HS Code 841939, HS Code 841610 and HS Code 851610) are negative. When assessed generally, it reveals the comparative advantage of the products (HS Code 732181, HS Code 732211 and HS Code 840310) due to RSCA >0. RSCA index results calculated for the products (HS Code 840220, HS Code 841610 and HS Code 851610) determined that the values are less than zero; therefore, Türkiye does not have a comparative advantage in these products. The TBI index values calculated for the products (HS Code 732181, HS Code 732211 and HS Code 840310) are greater than zero. Consequently, it reveals the net-exporter of these products. Though there are fluctuations, the TBI index value calculated for the products (HS Code 840220, HS Code 841610 and HS Code

Table 6. International competitiveness analysis for heating sub-product (2001-2006) (Compiled by authors).

Year	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2001	732181	3,16	3,21	0,18	3,03	1,24	0,51	0,88	Group A- RSCA>0, TBI>0
	732211	21,84	24,59	0,47	24,12	1,71	0,91	0,94	Group A-RSCA>0, TBI>0
	840220	0,04	0,04	0,98	-0,94	-1,33	-0,91	-0,93	Group D-RSCA<0, TBI<0
	840310	0,49	0,49	0,39	0,11	0,11	-0,34	0,04	Group C-RSCA<0, TBI>0
	840410	0,99	0,99	25,86	-24,86	-1,41	0,00	-0,95	Group B-RSCA>0, TBI<0
	841610	0,24	0,24	1,86	-1,62	-0,90	-0,62	-0,82	Group D-RSCA<0, TBI<0
	841939	0,15	0,15	2,38	-2,22	-1,19	-0,73	-0,90	Group D-RSCA<0, TBI<0
	851610	0,25	0,25	0,93	-0,68	-0,57	-0,60	-0,65	Group D-RSCA<0, TBI<0
2002	732181	2,88	2,92	0,15	2,76	1,26	0,48	0,88	Group A- RSCA>0, TBI>0
	732211	27,17	32,02	0,17	31,85	2,27	0,92	0,97	Group A-RSCA>0, TBI>0
	840220	0,07	0,07	1,50	-1,43	-1,31	-0,86	-0,93	Group D-RSCA<0, TBI<0
	840310	1,76	1,78	3,92	-2,14	-0,34	0,28	-0,48	Group B-RSCA>0, TBI<0
	840410	0,28	0,28	20,20	-19,92	-1,86	-0,56	-0,98	Group D-RSCA<0, TBI<0
	841610	0,30	0,30	1,80	-1,50	-0,77	-0,53	-0,78	Group D-RSCA<0, TBI<0
	841939	0,21	0,21	2,35	-2,14	-1,05	-0,66	-0,87	Group D-RSCA<0, TBI<0
	851610	0,19	0,19	1,00	-0,81	-0,72	-0,68	-0,75	Group D-RSCA<0, TBI<0
2003	732181	4,07	4,18	0,09	4,08	1,64	0,60	0,95	Group A-RSCA>0, TBI>0
	732211	32,89	41,50	0,02	41,48	3,15	0,94	0,99	Group A-RSCA>0, TBI>0
	840220	0,10	0,10	1,39	-1,29	-1,14	-0,82	-0,90	Group D-RSCA<0, TBI<0
	840310	4,58	4,73	4,53	0,20	0,02	0,64	-0,10	Group B-RSCA>0, TBI<0
	840410	0,28	0,28	4,56	-4,29	-1,22	-0,57	-0,93	Group D-RSCA<0, TBI<0
	841610	0,43	0,43	0,87	-0,43	-0,30	-0,39	-0,48	Group D-RSCA<0, TBI<0
	841939	0,23	0,23	1,81	-1,59	-0,91	-0,63	-0,83	Group D-RSCA<0, TBI<0
	851610	0,32	0,32	0,87	-0,55	-0,43	-0,52	-0,55	Group D-RSCA<0, TBI<0
2004	732181	2,81	2,87	0,11	2,76	1,41	0,47	0,93	Group A- RSCA>0, TBI>0
	732211	30,67	38,97	0,05	38,92	2,85	0,93	0,99	Group A-RSCA>0, TBI>0
	840220	0,08	0,09	1,40	-1,31	-1,20	-0,84	-0,92	Group D-RSCA<0, TBI<0
	840310	4,49	4,64	5,05	-0,40	-0,04	0,64	-0,18	Group B-RSCA>0, TBI<0
	840410	0,43	0,43	3,68	-3,25	-0,93	-0,40	-0,86	Group D-RSCA<0, TBI<0
	841610	0,30	0,30	0,87	-0,56	-0,46	-0,53	-0,62	Group D-RSCA<0, TBI<0
	841939	0,51	0,52	1,93	-1,41	-0,57	-0,32	-0,67	Group D-RSCA<0, TBI<0
	851610	0,46	0,46	1,25	-0,79	-0,43	-0,37	-0,54	Group D-RSCA<0, TBI<0
2005	732181	2,81	2,87	0,11	2,75	1,40	0,47	0,92	Group A-RSCA>0, TBI>0
	732211	31,06	39,85	0,04	39,81	2,97	0,93	0,99	Group A-RSCA>0, TBI>0
	840220	0,07	0,08	1,36	-1,29	-1,25	-0,86	-0,93	Group D-RSCA<0, TBI<0
	840310	4,64	4,81	5,48	-0,67	-0,06	0,65	-0,22	Group B-RSCA>0, TBI<0
	840410	1,55	1,57	5,06	-3,49	-0,51	0,22	-0,73	Group B-RSCA>0, TBI<0
	841610	0,71	0,71	0,68	0,03	0,02	-0,17	-0,19	Group D-RSCA<0, TBI<0
	841939	0,47	0,47	1,50	-1,03	-0,50	-0,36	-0,67	Group D-RSCA<0, TBI<0
	851610	0,68	0,68	1,88	-1,20	-0,44	-0,19	-0,63	Group D-RSCA<0, TBI<0
2006	732181	2,26	2,30	0,14	2,16	1,20	0,38	0,89	Group A-RSCA>0, TBI>0
	732211	26,22	32,27	0,53	31,74	1,78	0,92	0,93	Group A-RSCA>0, TBI>0
	840220	0,08	0,09	1,35	-1,26	-1,18	-0,84	-0,92	Group D-RSCA<0, TBI<0
	840310	4,18	4,32	5,91	-1,59	-0,14	0,61	-0,32	Group B-RSCA>0, TBI<0
	840410	0,81	0,81	4,03	-3,21	-0,69	-0,11	-0,79	Group D-RSCA<0, TBI<0
	841610	0,80	0,80	0,62	0,19	0,12	-0,11	-0,09	Group D-RSCA<0, TBI<0
	841939	0,52	0,52	1,68	-1,15	-0,51	-0,32	-0,64	Group D-RSCA<0, TBI<0
	851610	0,93	0,94	1,77	-0,83	-0,28	-0,03	-0,51	Group D-RSCA<0, TBI<0

Table 7. International competitiveness analysis for heating sub-product (2007-2014) (Compiled by authors).

Year	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2007	732181	2,33	2,37	0,15	2,21	1,17	0,40	0,88	Group A-RSCA>0, TBI>0
	732211	24,60	30,43	0,24	30,19	2,10	0,92	0,97	Group A-RSCA>0, TBI>0
	840220	0,09	0,09	1,39	-1,30	-1,18	-0,83	-0,92	Group D-RSCA<0, TBI<0
	840310	4,46	4,62	4,67	-0,05	0,00	0,63	-0,16	Group B-RSCA>0, TBI<0
	840410	1,10	1,11	3,23	-2,13	-0,47	0,05	-0,67	Group B-RSCA>0, TBI<0
	841610	0,82	0,83	0,45	0,37	0,26	-0,10	0,08	Group C-RSCA<0, TBI>0
	841939	1,06	1,07	2,02	-0,95	-0,28	0,03	-0,51	Group B-RSCA>0, TBI<0
	851610	0,61	0,61	1,17	-0,56	-0,28	-0,24	-0,49	Group D-RSCA<0, TBI<0
2008	732181	2,13	2,17	0,14	2,02	1,16	0,36	0,89	Group A-RSCA>0, TBI>0
	732211	21,83	26,64	0,07	26,57	2,55	0,91	0,99	Group A-RSCA>0, TBI>0
	840220	0,05	0,06	1,26	-1,20	-1,34	-0,89	-0,94	Group D-RSCA<0, TBI<0
	840310	4,57	4,76	4,22	0,54	0,05	0,64	-0,08	Group B-RSCA>0, TBI<0
	840410	1,07	1,08	1,26	-0,18	-0,07	0,03	-0,33	Group B-RSCA>0, TBI<0
	841610	0,44	0,44	0,72	-0,27	-0,21	-0,39	-0,41	Group D-RSCA<0, TBI<0
	841939	0,58	0,58	1,90	-1,31	-0,51	-0,26	-0,64	Group D-RSCA<0, TBI<0
	851610	0,71	0,71	1,11	-0,39	-0,19	-0,17	-0,41	Group D-RSCA<0, TBI<0
2009	732181	5,02	5,24	0,26	4,97	1,29	0,66	0,88	Group A-RSCA>0, TBI>0
	732211	23,23	28,75	0,63	28,12	1,65	0,91	0,93	Group A-RSCA>0, TBI>0
	840220	0,09	0,10	1,43	-1,33	-1,17	-0,82	-0,90	Group D-RSCA<0, TBI<0
	840310	5,77	6,07	3,16	2,91	0,28	0,70	0,22	Group A-RSCA>0, TBI>0
	840410	0,97	0,98	0,84	0,14	0,07	-0,01	-0,13	Group D-RSCA<0, TBI<0
	841610	0,55	0,56	0,68	-0,12	-0,09	-0,29	-0,18	Group D-RSCA<0, TBI<0
	841939	0,73	0,73	2,15	-1,42	-0,47	-0,16	-0,62	Group D-RSCA<0, TBI<0
	851610	0,54	0,54	0,86	-0,32	-0,20	-0,30	-0,39	Group D-RSCA<0, TBI<0
2010	732181	9,71	10,48	0,22	10,25	1,67	0,81	0,91	Group A-RSCA>0, TBI>0
	732211	25,44	31,49	0,32	31,16	1,97	0,92	0,96	Group A-RSCA>0, TBI>0
	840220	0,11	0,12	1,70	-1,58	-1,16	-0,79	-0,91	Group D-RSCA<0, TBI<0
	840310	7,07	7,49	3,24	4,25	0,36	0,75	0,23	Group A-RSCA>0, TBI>0
	840410	0,39	0,39	0,81	-0,42	-0,32	-0,44	-0,41	Group D-RSCA<0, TBI<0
	841610	0,83	0,83	0,68	0,15	0,09	-0,09	-0,14	Group D-RSCA<0, TBI<0
	841939	1,02	1,03	1,09	-0,06	-0,03	0,01	-0,30	Group B-RSCA>0, TBI<0
	851610	0,51	0,52	0,84	-0,33	-0,21	-0,32	-0,49	Group D-RSCA<0, TBI<0
2011	732181	2,52	2,57	0,18	2,39	1,14	0,43	0,73	Group A-RSCA>0, TBI>0
	732211	23,18	28,02	0,27	27,75	2,00	0,91	0,96	Group A-RSCA>0, TBI>0
	840220	0,14	0,14	1,57	-1,43	-1,04	-0,75	-0,89	Group D-RSCA<0, TBI<0
	840310	8,81	9,45	3,71	5,74	0,41	0,80	0,23	Group A-RSCA>0, TBI>0
	840410	0,55	0,55	1,00	-0,45	-0,26	-0,29	-0,32	Group D-RSCA<0, TBI<0
	841610	0,92	0,93	0,57	0,36	0,21	-0,04	0,02	Group C-RSCA<0, TBI>0
	841939	1,00	1,01	3,57	-2,56	-0,55	0,00	-0,71	Group B-RSCA>0, TBI<0
	851610	0,60	0,60	0,83	-0,23	-0,14	-0,25	-0,46	Group D-RSCA<0, TBI<0
2012	732181	3,69	3,81	0,22	3,58	1,22	0,57	0,81	Group A-RSCA>0, TBI>0
	732211	23,47	29,15	0,17	28,98	2,22	0,91	0,97	Group A-RSCA>0, TBI>0
	840220	0,10	0,10	1,78	-1,68	-1,23	-0,81	-0,92	Group D-RSCA<0, TBI<0
	840310	8,05	8,65	3,50	5,15	0,39	0,78	0,27	Group A-RSCA>0, TBI>0
	840410	0,99	1,00	1,41	-0,41	-0,15	0,00	-0,30	Group B-RSCA>0, TBI<0
	841610	0,72	0,73	0,54	0,19	0,13	-0,16	0,01	Group C-RSCA<0, TBI>0
	841939	1,41	1,43	1,70	-0,27	-0,08	0,17	-0,32	Group D-RSCA<0, TBI<0
	851610	0,75	0,75	0,54	0,21	0,14	-0,15	-0,11	Group D-RSCA<0, TBI<0
2013	732181	2,75	2,81	0,29	2,52	0,97	0,46	0,69	Group A-RSCA>0, TBI>0
	732211	20,35	24,65	0,16	24,48	2,16	0,90	0,97	Group A-RSCA>0, TBI>0
	840220	0,09	0,09	1,80	-1,71	-1,29	-0,83	-0,93	Group D-RSCA<0, TBI<0
	840310	8,18	8,81	2,73	6,08	0,51	0,78	0,37	Group A-RSCA>0, TBI>0
	840410	0,78	0,79	5,42	-4,63	-0,84	-0,12	-0,79	Group D-RSCA<0, TBI<0
	841610	0,70	0,71	0,53	0,18	0,13	-0,17	-0,02	Group D-RSCA<0, TBI<0
	841939	0,98	0,99	1,95	-0,96	-0,29	-0,01	-0,53	Group D-RSCA<0, TBI<0
	851610	0,62	0,62	0,39	0,23	0,20	-0,23	-0,07	Group D-RSCA<0, TBI<0
2014	732181	3,06	3,14	0,66	2,48	0,67	0,50	0,53	Group A-RSCA>0, TBI>0
	732211	15,99	18,63	0,38	18,24	1,68	0,88	0,92	Group A-RSCA>0, TBI>0
	840220	0,17	0,17	1,93	-1,75	-1,03	-0,70	-0,87	Group D-RSCA<0, TBI<0
	840310	9,00	9,80	2,22	7,58	0,65	0,80	0,49	Group A-RSCA>0, TBI>0
	840410	0,41	0,41	1,31	-0,90	-0,50	-0,42	-0,59	Group D-RSCA<0, TBI<0
	841610	0,82	0,82	0,52	0,30	0,20	-0,10	0,06	Group C-RSCA<0, TBI>0
	841939	0,93	0,93	1,66	-0,72	-0,25	-0,04	-0,48	Group D-RSCA<0, TBI<0
	851610	0,48	0,48	0,19	0,29	0,40	-0,35	0,21	Group C-RSCA<0, TBI>0

Table 8. International competitiveness analysis for heating sub-product (2015-2021) (Compiled by authors).

Year	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2015	732181	2,11	2,15	0,47	1,68	0,65	0,35	0,59	Group A-RSCA>0, TBI>0
	732211	17,79	21,27	0,14	21,13	2,17	0,89	0,97	Group A-RSCA>0, TBI>0
	840220	0,15	0,15	1,86	-1,71	-1,09	-0,74	-0,88	Group D-RSCA<0, TBI<0
	840310	9,45	10,38	2,51	7,87	0,62	0,81	0,49	Group A-RSCA>0, TBI>0
	840410	0,54	0,54	1,75	-1,21	-0,51	-0,30	-0,58	Group D-RSCA<0, TBI<0
	841610	0,71	0,71	0,51	0,20	0,15	-0,17	0,01	Group C-RSCA<0, TBI>0
	841939	1,02	1,03	2,45	-1,42	-0,37	0,01	-0,55	Group B-RSCA>0, TBI<0
	851610	0,38	0,38	0,65	-0,27	-0,23	-0,45	-0,46	Group D-RSCA<0, TBI<0
2016	732181	1,13	1,14	0,43	0,71	0,42	0,06	0,34	Group A-RSCA>0, TBI>0
	732211	15,17	17,69	0,08	17,60	2,32	0,87	0,98	Group A-RSCA>0, TBI>0
	840220	0,15	0,15	1,76	-1,61	-1,06	-0,74	-0,87	Group D-RSCA<0, TBI<0
	840310	9,49	10,44	2,39	8,04	0,64	0,81	0,53	Group A-RSCA>0, TBI>0
	840410	0,45	0,45	1,63	-1,18	-0,56	-0,38	-0,60	Group D-RSCA<0, TBI<0
	841610	0,44	0,44	0,40	0,04	0,04	-0,39	-0,07	Group D-RSCA<0, TBI<0
	841939	1,24	1,25	1,85	-0,60	-0,17	0,11	-0,38	Group B-RSCA>0, TBI<0
	851610	0,38	0,39	0,45	-0,07	-0,07	-0,44	-0,30	Group D-RSCA<0, TBI<0
2017	732181	1,41	1,43	0,33	1,10	0,63	0,17	0,57	Group A-RSCA>0, TBI>0
	732211	15,21	17,73	0,06	17,67	2,45	0,87	0,98	Group A-RSCA>0, TBI>0
	840220	0,15	0,15	1,76	-1,60	-1,06	-0,74	-0,87	Group D-RSCA<0, TBI<0
	840310	10,07	11,15	2,34	8,81	0,68	0,82	0,54	Group A-RSCA>0, TBI>0
	840410	1,61	1,64	0,58	1,06	0,45	0,24	0,43	Group A-RSCA>0, TBI>0
	841610	0,70	0,70	0,86	-0,16	-0,09	-0,18	-0,22	Group D-RSCA<0, TBI<0
	841939	1,12	1,13	1,18	-0,05	-0,02	0,06	-0,21	Group B-RSCA>0, TBI<0
	851610	0,43	0,43	0,41	0,01	0,01	-0,40	-0,24	Group D-RSCA<0, TBI<0
2018	732181	1,15	1,16	0,17	0,99	0,82	0,07	0,72	Group A-RSCA>0, TBI>0
	732211	15,72	18,36	0,11	18,25	2,19	0,88	0,97	Group A-RSCA>0, TBI>0
	840220	0,11	0,11	1,68	-1,57	-1,16	-0,79	-0,89	Group D-RSCA<0, TBI<0
	840310	10,89	12,13	2,78	9,35	0,64	0,83	0,56	Group A-RSCA>0, TBI>0
	840410	0,81	0,82	0,57	0,24	0,15	-0,11	0,04	Group C-RSCA<0, TBI>0
	841610	1,31	1,33	1,45	-0,13	-0,04	0,13	-0,16	Group B-RSCA>0, TBI<0
	841939	1,11	1,12	1,95	-0,82	-0,24	0,05	-0,37	Group B-RSCA>0, TBI<0
	851610	0,47	0,48	0,36	0,12	0,13	-0,36	-0,04	Grup D-RSCA<0, TBI<0
2019	732181	0,97	0,98	0,17	0,81	0,75	-0,01	0,70	Group C-RSCA<0, TBI>0
	732211	15,76	18,59	0,64	17,95	1,46	0,88	0,89	Group A-RSCA>0, TBI>0
	840220	0,32	0,33	2,16	-1,83	-0,82	-0,50	-0,76	Group D-RSCA<0, TBI<0
	840310	10,14	11,27	1,98	9,29	0,75	0,82	0,66	Group A-RSCA>0, TBI>0
	840410	1,32	1,34	0,38	0,96	0,55	0,14	0,59	Group A-RSCA>0, TBI>0
	841610	0,88	0,89	0,38	0,51	0,37	-0,06	0,25	Group C-RSCA<0, TBI>0
	841939	1,11	1,12	1,01	0,11	0,05	0,05	-0,03	Group B-RSCA>0, TBI<0
	851610	0,45	0,45	0,31	0,14	0,16	-0,38	0,04	Group C-RSCA<0, TBI>0
2020	732181	1,13	1,14	0,11	1,02	1,00	0,06	0,81	Group A- RSCA>0, TBI>0
	732211	13,88	16,04	0,40	15,64	1,59	0,86	0,92	Group A-RSCA>0, TBI>0
	840220	0,26	0,26	2,09	-1,83	-0,90	-0,59	-0,82	Group D-RSCA<0, TBI<0
	840310	10,21	11,36	2,04	9,32	0,75	0,82	0,63	Group A-RSCA>0, TBI>0
	840410	0,68	0,69	0,67	0,01	0,01	-0,19	-0,07	Group D-RSCA<0, TBI<0
	841610	0,85	0,85	0,45	0,41	0,28	-0,08	0,09	Group C-RSCA<0, TBI>0
	841939	1,51	1,53	1,41	0,12	0,04	0,20	-0,09	Group B-RSCA>0, TBI<0
	851610	0,47	0,47	0,42	0,05	0,05	-0,36	-0,15	Group D-RSCA<0, TBI<0
2021	732181	1,09	1,10	1,23	-0,13	-0,05	0,04	0,76	Group A -RSCA>0, TBI>0
	732211	14,09	16,45	0,09	16,36	2,23	0,86	0,97	Group A-RSCA>0, TBI>0
	840220	0,26	0,26	2,26	-1,99	-0,93	-0,58	-0,82	Group D-RSCA<0, TBI<0
	840310	9,21	10,19	1,31	8,88	0,89	0,80	0,74	Group A-RSCA>0, TBI>0
	840410	0,96	0,97	0,72	0,25	0,13	-0,02	0,14	Group C-RSCA<0, TBI>0
	841610	1,11	1,12	0,58	0,54	0,28	0,05	0,25	Group A-RSCA>0, TBI>0
	841939	1,74	1,77	1,48	0,29	0,08	0,27	0,03	Group A-RSCA>0, TBI>0
	851610	0,50	0,51	0,45	0,06	0,05	-0,33	-0,12	Group D-RSCA<0, TBI<0

851610) is less than zero, thus it reveals the net-importer of these products. According to the product mapping method, the products (HS Code 732181, HS Code 732211 and HS Code 840310) are included in Group A. The explanation for this is that it has been determined that net-exports (GROUP A) have a comparative advantage in the trade of these products. Although it differs from time to time, the products (HS Code 851610, HS Code 840410 and HS Code 841939) are involved in Group D.

Table 9-10 indicate the international competitiveness analysis results for the refrigeration sub-sector. When the RCA index results calculated for the products (HS Code 841891 and HS Code 841850) are evaluated in general, it is comprehended that the values are 1 and above. The average values of the index results are

respectively calculated as 1.91 and 4.60. RXA index results are parallel to RCA index results. Therefore, according to the results of these two indexes, it has been revealed that Türkiye has competitiveness in these products and specializes in its exports**.** However, when the RCA index results for the other two products (HS Code 841990 and HS Code 841989) were examined in general, it was determined that the calculated values were 1 and below. The average value of the index results was respectively calculated as 0.70 and 0.35. These results are parallel to the RXA index. Hence, according to the results of these two indexes, it has been concluded that Türkiye does not have competitive power in these products and does not specialize in exports. In order for the RMP Index to gain competitive advantage in the relevant sector or product group, the calculated values require to below one. The RMP index results calculated for the products (HS Code 841891 and HS Code 841850) are below 1, thus it reveals that comparative advantage of these products. The RMP index values calculated for the non-competitive product (HS Code 841490) are below 1, thus it reveals that meagre import of this product. The calculated RMP index values of the product (HS Code 841989) are above 1, which in this context reveals the comparative disadvantage of this product. RTA and RC indices, which take both export and import aspects into consideration, will offer objective results. When the results of these two indexes are evaluated in general, the values calculated for the product (HS Code 841891 and HS Code 841850) are positive. Therefore, it has been determined that Türkiye has a competitive advantage in these products. The indices calculated for the product (HS Code 841490) are negative in the periods covering the years 2001-2004. Throughout all periods, the results of both indexes are negative for this product (HS Code 841989). Therefore, it has been revealed that Türkiye has a competitive disadvantage in these products. In general evaluation, due to RSCA>0, it reveals the comparative advantage of the products (HS Code 841891 and HS Code 841850). The RSCA index values analyzed for the products (HS Code 841990 and HS Code 841989) are less than zero, hence it has been determined that Türkiye does not have a comparative advantage in these products. When examined in general, the TBI index values analyzed for the products (HS Code 841891 and HS Code 841850) are greater than zero, thus it reveals that the net-exporter of these products. The fact that the TBI index values for the product (HS Code 841490) calculated in the 2001-2004, 2011, 2013 and 2020 periods are less than zero hence, it indicates that the net-importer of this product. TBI index values calculated for the product (HS Code 841989) are less than zero throughout totally periods; thus, Türkiye is in a net-importer for this product. Although there are alters from time to time according to the product mapping method, the products (HS Code 841891 and HS Code 841850) are included in Group A. In this context, it has been concluded that Türkiye is a net-exporter (GROUP A) with a comparative advantage in these products. The product (HS Code 841989) is involved in Group D and it has been determined that Türkiye is a net-importer with a comparative disadvantage in this product. The product (HS Code 841490) is involved in Group C for the periods 2005-2010, 2012, 2014-2019 and 2021, however, when it was generally evaluated results, this product is included in Group D.

Table 9. International competitiveness analysis for refrigeration sub-product (2001-2007) (Compiled by authors).

	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2001	841891	0,31	0,31	1,74	-1,43	-0,74	-0,52	-0,78	Group D-RSCA<0, TBI<0
	841490	0,39	0,39	0,57	-0,17	-0,16	-0,44	-0,26	Group D-RSCA<0, TBI<0
	841850	0,87	0,87	0,88	-0,01	-0,01	-0,07	-0,07	Group D-RSCA<0, TBI<0
	841989	0,07	0,07	2,37	-2,29	-1,50	-0,86	-0,96	Group D-RSCA<0, TBI<0
2002	841891	0,25	0,26	0,67	-0,41	-0,42	-0,59	-0,69	Group D-RSCA<0, TBI<0
	841490	0,36	0,37	0,68	-0,31	-0,27	-0,47	-0,45	Group D-RSCA<0, TBI<0
	841850	2,03	2,05	0,38	1,67	0,73	0,34	0,62	Group A-RSCA>0, TBI>0
	841989	0,10	0,10	1,40	-1,29	-1,13	-0,81	-0,92	Group D-RSCA<0, TBI<0
2003	841891	0,42	0,42	0,37	0,05	0,05	-0,41	-0,20	Group D-RSCA<0, TBI<0
	841490	0,36	0,36	0,62	-0,26	-0,24	-0,47	-0,43	Group D-RSCA<0, TBI<0
	841850	3,40	3,48	0,39	3,08	0,94	0,55	0,75	Group A-RSCA>0, TBI>0
	841989	0,11	0,11	1,11	-1,00	-1,01	-0,80	-0,88	Group D-RSCA<0, TBI<0
2004	841891	0,61	0,61	0,49	0,12	0,10	-0,24	-0,30	Group D-RSCA<0, TBI<0
	841490	0,39	0,39	0,72	-0,33	-0,26	-0,44	-0,47	Group D-RSCA<0, TBI<0
	841850	3,33	3,41	0,55	2,86	0,79	0,54	0,65	Group A-RSCA>0, TBI>0
	841989	0,12	0,12	0,91	-0,79	-0,90	-0,79	-0,85	Group D-RSCA<0, TBI<0
2005	841891	1,28	1,30	0,27	1,03	0,68	0,12	0,34	Group A-RSCA>0, TBI>0
	841490	0,67	0,67	0,41	0,26	0,21	-0,20	0,01	Group C-RSCA<0, TBI>0
	841850	4,16	4,29	0,70	3,60	0,79	0,61	0,61	Group A-RSCA>0, TBI>0
	841989	0,18	0,18	1,10	-0,92	-0,78	-0,69	-0,83	Group D-RSCA<0, TBI<0
2006	841891	1,15	1,16	0,63	0,53	0,26	0,07	-0,26	Group B-RSCA>0, TBI<0
	841490	0,89	0,89	0,51	0,39	0,25	-0,06	0,02	Group C-RSCA<0, TBI>0
	841850	3,31	3,39	1,21	2,18	0,45	0,54	0,31	Group A-RSCA>0, TBI>0
	841989	0,19	0,19	1,04	-0,85	-0,74	-0,68	-0,82	Group D-RSCA<0, TBI<0
2007	841891	1,22	1,23	0,25	0,98	0,69	0,10	0,34	Group A-RSCA>0, TBI>0
	841490	0,98	0,99	0,46	0,53	0,33	-0,01	0,12	Group C-RSCA<0, TBI>0
	841850	3,58	3,69	0,90	2,78	0,61	0,56	0,47	Group A-RSCA>0, TBI>0
	841989	0,18	0,18	1,02	-0,85	-0,76	-0,70	-0,81	Group D-RSCA<0, TBI<0

Table 10. International competitiveness analysis for refrigeration sub-product (2008-2021) (Compiled by authors).

	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2008	841891	0,33	0,33	0,15	0,18	0,34	-0,50	0,37	Group C-RSCA<0, TBI>0
	841490	0,87	0,88	0,44	0,44	0,31	-0,07	0,12	Group C-RSCA<0, TBI>0
	841850	3,85	3,99	0,68	3,31	0,77	0,59	0,61	Group A-RSCA>0, TBI>0
	841989	0,29	0,29	0,89	-0,59	-0,48	-0,55	-0,68	Group D-RSCA<0, TBI<0
2009	841891	1,55	1,57	0,26	1,31	0,78	0,22	0,56	Group A-RSCA>0, TBI>0
	841490	0,84	0,85	0,54	0,31	0,20	-0,08	0,09	Group C-RSCA<0, TBI>0
	841850	4,45	4,63	0,48	4,15	0,98	0,63	0,76	Group A-RSCA>0, TBI>0
	841989	0,23	0,24	0,92	-0,69	-0,59	-0,62	-0,70	Group D-RSCA<0, TBI<0
2010	841891	1,00	1,01	0,09	0,91	1,03	0,00	0,65	Group A-RSCA>0, TBI>0
	841490	0,88	0,89	0,44	0,44	0,30	-0,06	0,11	Group C-RSCA<0, TBI>0
	841850	5,85	6,13	0,58	5,55	1,02	0,71	0,73	Group A-RSCA>0, TBI>0
	841989	0,58	0,58	0,74	-0,16	-0,11	-0,27	-0,43	Group D-RSCA<0, TBI<0
2011	841891	0,96	0,96	0,17	0,79	0,75	-0,02	0,45	Group C-RSCA<0, TBI>0
	841490	0,84	0,85	0,53	0,31	0,20	-0,09	-0,06	Group D-RSCA<0, TBI<0
	841850	7,21	7,63	0,62	7,01	1,09	0,76	0,75	Group A-RSCA>0, TBI>0
	841989	0,41	0,41	0,86	-0,45	-0,32	-0,42	-0,56	Group D-RSCA<0, TBI<0
2012	841891	1,06	1,07	0,14	0,93	0,87	0,03	0,59	Group A-RSCA>0, TBI>0
	841490	0,69	0,69	0,43	0,27	0,21	-0,18	0,04	Group C-RSCA<0, TBI>0
	841850	5,86	6,17	0,50	5,67	1,09	0,71	0,77	Group A-RSCA>0, TBI>0
	841989	0,44	0,44	1,33	-0,89	-0,48	-0,39	-0,66	Group D-RSCA<0, TBI<0
2013	841891	1,74	1,77	0,04	1,73	1,66	0,27	0,90	Group A-RSCA>0, TBI>0
	841490	0,74	0,75	0,49	0,26	0,18	-0,15	-0,04	Group D-RSCA<0, TBI<0
	841850	6,08	6,43	0,58	5,84	1,04	0,72	0,74	Group A-RSCA>0, TBI>0
	841989	0,38	0,38	1,60	-1,22	-0,62	-0,45	-0,75	Group D-RSCA<0, TBI<0
2014	841891	2,39	2,44	0,09	2,36	1,46	0,41	0,86	Group A-RSCA>0, TBI>0
	841490	0,69	0,69	0,33	0,36	0,32	-0,18	0,17	Group C-RSCA<0, TBI>0
	841850	6,68	7,11	0,49	6,62	1,16	0,74	0,81	Group A-RSCA>0, TBI>0
	841989	0,43	0,43	1,10	-0,67	-0,41	-0,40	-0,63	Group D-RSCA<0, TBI<0
2015	841891	1,41	1,43	0,08	1,35	1,26	0,17	0,83	Group A-RSCA>0, TBI>0
	841490	0,62	0,63	0,36	0,27	0,25	-0,23	0,13	Group C-RSCA<0, TBI>0
	841850	4,97	5,22	0,41	4,81	1,10	0,67	0,80	Group A-RSCA>0, TBI>0
	841989	0,40	0,41	1,12	-0,72	-0,44	-0,42	-0,62	Group D-RSCA<0, TBI<0
2016	841891	4,48	4,67	0,08	4,59	1,75	0,63	0,94	Group A-RSCA>0, TBI>0
	841490	0,62	0,63	0,39	0,24	0,21	-0,23	0,09	Group C-RSCA<0, TBI>0
	841850	4,85	5,08	0,36	4,73	1,15	0,66	0,83	Group A-RSCA>0, TBI>0
	841989	0,39	0,39	2,71	-2,33	-0,85	-0,44	-0,82	Group D-RSCA<0, TBI<0
2017	841891	5,74	6,07	0,06	6,01	2,01	0,70	0,96	Group A-RSCA>0, TBI>0
	841490	0,71	0,72	0,43	0,29	0,23	-0,17	0,08	Group C-RSCA<0, TBI>0
	841850	4,78	5,02	0,26	4,76	1,29	0,65	0,87	Group A-RSCA>0, TBI>0
	841989	0,40	0,40	1,47	-1,07	-0,56	-0,43	-0,71	Group D-RSCA<0, TBI<0
2018	841891	3,64	3,77	0,03	3,73	2,04	0,57	0,97	Group A-RSCA>0, TBI>0
	841490	0,77	0,78	0,42	0,36	0,26	-0,13	0,19	Group C-RSCA<0, TBI>0
	841850	5,16	5,42	0,24	5,18	1,35	0,68	0,90	Group A-RSCA>0, TBI>0
	841989	0,52	0,53	1,02	-0,49	-0,29	-0,31	-0,42	Group D-RSCA<0, TBI<0
2019	841891	2,58	2,65	0,05	2,59	1,71	0,44	0,95	Group A-RSCA>0, TBI>0
	841490	0,77	0,78	0,55	0,23	0,15	-0,13	0,11	Group C-RSCA<0, TBI>0
	841850	5,31	5,61	0,20	5,41	1,44	0,68	0,92	Group A-RSCA>0, TBI>0
	841989	0,66	0,67	1,03	-0,36	-0,19	-0,20	-0,31	Group D-RSCA<0, TBI<0
2020	841891	3,66	3,79	0,11	3,68	1,53	0,57	0,91	Group A-RSCA>0, TBI>0
	841490	0,79	0,80	0,72	0,07	0,04	-0,12	-0,07	Group D-RSCA<0, TBI<0
	841850	5,45	5,76	0,20	5,56	1,46	0,69	0,91	Group A-RSCA>0, TBI>0
	841989	0,56	0,57	1,11	-0,55	-0,29	-0,28	-0,44	Group D-RSCA<0, TBI<0
2021	841891	4,32	4,52	0,61	3,91	0,87	0,62	0,68	Group A-RSCA>0, TBI>0
	841490	0,85	0,86	0,49	0,37	0,24	-0,08	0,19	Group C-RSCA<0, TBI>0
	841850	5,38	5,70	0,21	5,49	1,44	0,69	0,89	Group A-RSCA>0, TBI>0
	841989	0,64	0,65	1,54	-0,90	-0,38	-0,22	-0,48	Group D-RSCA<0, TBI<0

Table 11 displays the international competitiveness analysis results for the air conditioning sub-product. It was determined that the RCA index values calculated for the product (HS Code 841430) in the 2001-2021 periods were below 1. The results are parallel to the RXA index. The calculated value for the product of these two indices was recorded as 0.27. Therefore, according to these two indices, it has been revealed that Türkiye does not have competitive power in the product and does not specialize in exports. When the RCA index results calculated for the product (HS Code 841520) are examined, it is realized that the values in the 2008-2011 and 2016-2019 periods are 1 and above. The average value of the RCA index was calculated as 0.79, and the average value of the RXA index was calculated as 0.80. Hence, according to the results of these two indexes, it has been determined that Türkiye does not have competitiveness in this product and does not specialize in its exports. In order for the RMP Index

to gain competitive advantage in the relevant sector or product group, the calculated values necessitate to below one. The calculated values for the product (HS Code 841430) are above 1, therefore it indicates that the comparative disadvantage of the product. The RMP index values analyzed for the product (HS Code 841520) are below 1, thus it reveals that the import of this product is meagre. RTA and RC indices, which take both export and import aspects into consideration, will provide objective results. The results of these two indexes indicate that the values calculated for the product (HS Code 841430) are negative throughout the whole period (2001-2021), thus it demonstrates that the comparative disadvantage of this product. The values analyzed for the product (HS Code 841520) in the 2001-2007, 2014-2015 and 2020-2021 periods are negative, therefore it was revealed that this product has a competitive disadvantage. RSCA index values calculated for the product (HS Code 841430) throughout totally periods are less than zero, thus it indicates that product has a comparative disadvantage. It has been determined that Türkiye does not have a comparative advantage in this product (HS Code 841520) due to RSCA<0 in the 2001-2007, 2012-2015 and 2020-2021 periods. The fact that the TBI index is less than zero throughout the periods considered reveals the net-importer of the product (HS Code 841430). TBI index reveals the net-importer of the product (HS Code 841520), because it is less than zero in other periods except the 2008-2011 and 2018-2019 periods. According to the product mapping method, the product (HS Code 841430) is included in Group D. The explanation for this is that it has been concluded that Türkiye is a net-importer (GROUP D) with a comparative disadvantage in trade in this product. The other product (HS Code 841520) is involved in Group D in the 2001-2007, 2012-2015 and 2020-2021 periods, while the product is included in Group A in the 2008-2011 and 2018-2019 periods. However, when evaluated in general, this product is involved in Group D.

Table 11. International competitiveness analysis for air conditioning sub-product (2001-2021) (Compiled by authors).

	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2001	841430	0,23	0,23	1,40	-1,16	-0,77	-0,62	-0,78	Group D-RSCA<0, TBI<0
	841520	0,01	0,01	0,35	-0,34	-1,67	-0,99	-0,97	Group D-RSCA<0, TBI<0
2002	841430	0,19	0,19	1,61	-1,42	-0,93	-0,68	-0,85	Group D-RSCA<0, TBI<0
	841520	0,00	0,00	0,21	-0,20	-1,67	-0,99	-0,97	Group D-RSCA<0, TBI<0
2003	841430	0,36	0,36	1,81	-1,45	-0,70	-0,47	-0,76	Group D-RSCA<0, TBI<0
	841520	0,01	0,01	0,43	-0,42	-1,67	-0,98	-0,97	Group D-RSCA<0, TBI<0
2004	841430	0,39	0,39	2,33	-1,94	-0,77	-0,44	-0,79	Group D-RSCA<0, TBI<0
	841520	0,02	0,02	0,50	-0,48	-1,37	-0,96	-0,94	Group D-RSCA<0, TBI<0
2005	841430	0,33	0,33	2,68	-2,35	-0,91	-0,50	-0,85	Group D-RSCA<0, TBI<0
	841520	0,05	0,05	0,29	-0,23	-0,72	-0,90	-0,78	Group D-RSCA<0, TBI<0
2006	841430	0,37	0,37	2,99	-2,62	-0,91	-0,46	-0,85	Group D-RSCA<0, TBI<0
	841520	0,09	0,09	0,13	-0,04	-0,15	-0,83	-0,40	Group D-RSCA<0, TBI<0
2007	841430	0,43	0,43	3,26	-2,83	-0,88	-0,40	-0,83	Group D-RSCA<0, TBI<0
	841520	0,56	0,57	0,58	-0,02	-0,01	-0,28	-0,24	Group D-RSCA<0, TBI<0
2008	841430	0,46	0,47	3,30	-2,83	-0,85	-0,37	-0,81	Group D-RSCA<0, TBI<0
	841520	1,36	1,37	0,70	0,67	0,29	0,15	0,09	Group A-RSCA>0, TBI>0
2009	841430	0,55	0,55	3,92	-3,37	-0,85	-0,29	-0,79	Group D-RSCA<0, TBI<0
	841520	1,05	1,06	0,29	0,77	0,56	0,02	0,43	Group A-RSCA>0, TBI>0
2010	841430	0,39	0,39	3,31	-2,91	-0,92	-0,44	-0,84	Group D-RSCA<0, TBI<0
	841520	1,67	1,69	0,52	1,17	0,52	0,25	0,30	Group A-RSCA>0, TBI>0
2011	841430	0,29	0,29	3,17	-2,88	-1,04	-0,55	-0,89	Group D-RSCA<0, TBI<0
	841520	1,50	1,52	0,78	0,74	0,29	0,20	0,02	Group A-RSCA>0, TBI>0
2012	841430	0,17	0,17	2,99	-2,82	-1,25	-0,71	-0,93	Group D-RSCA<0, TBI<0
	841520	0,75	0,76	0,75	0,01	0,00	-0,14	-0,22	Group D-RSCA<0, TBI<0
2013	841430	0,14	0,14	2,87	-2,73	-1,30	-0,75	-0,94	Group D-RSCA<0, TBI<0
	841520	0,94	0,95	0,77	0,18	0,09	-0,03	-0,19	Group D-RSCA<0, TBI<0
2014	841430	0,21	0,21	2,55	-2,34	-1,08	-0,65	-0,89	Group D-RSCA<0, TBI<0
	841520	0,69	0,70	0,92	-0,22	-0,12	-0,18	-0,36	Group D-RSCA<0, TBI<0
2015	841430	0,13	0,13	2,59	-2,45	-1,28	-0,76	-0,92	Group D-RSCA<0, TBI<0
	841520	0,68	0,69	0,86	-0,18	-0,10	-0,19	-0,28	Group D-RSCA<0, TBI<0
2016	841430	0,14	0,14	2,73	-2,60	-1,30	-0,76	-0,92	Group D-RSCA<0, TBI<0
	841520	1,02	1,03	0,81	0,22	0,10	0,01	-0,06	Group B-RSCA>0, TBI<0
2017	841430	0,18	0,18	2,83	-2,65	-1,19	-0,69	-0,91	Group D-RSCA<0, TBI<0
	841520	1,03	1,04	0,88	0,16	0,07	0,02	-0,08	Group B-RSCA>0, TBI<0
2018	841430	0,20	0,20	3,29	-3,09	-1,22	-0,67	-0,90	Group D-RSCA<0, TBI<0
	841520	1,70	1,73	1,04	0,69	0,22	0,26	0,14	Group A-RSCA>0, TBI>0
2019	841430	0,15	0,15	3,33	-3,18	-1,35	-0,74	-0,92	Group D-RSCA<0, TBI<0
	841520	1,67	1,70	1,02	0,67	0,22	0,25	0,21	Group A-RSCA>0, TBI>0
2020	841430	0,19	0,19	3,64	-3,45	-1,29	-0,69	-0,92	Group D-RSCA<0, TBI<0
	841520	0,90	0,91	0,93	-0,02	-0,01	-0,05	-0,11	Group D-RSCA<0, TBI<0
2021	841430	0,17	0,17	3,74	-3,57	-1,35	-0,72	-0,92	Group D-RSCA<0, TBI<0
	841520	0,86	0,87	0,90	-0,03	-0,02	-0,08	-0,06	Group D-RSCA<0, TBI<0

Table 12 demonstrates the international competitiveness analysis results for the ventilation sub-product. The RCA index values calculated for the products (HS Code 830710 and HS Code 841460) are above 1. The average values of the index results were respectively calculated as 2.88 and 4.26. RCA index results and RXA index results are similar. In this context, it has been determined that Türkiye has competitiveness in these products and indicates specialization in exports. In order for the RMP Index to gain competitive advantage in the relevant sector or product group, the calculated values require to below one. In this context, when both products are evaluated in general, the calculated values are below 1. Therefore, it reveals the comparative advantage of these two products (HS Code 830710 and HS Code 841460). RTA and RC index values, which take into account both export and import aspects, are positive. Therefore, it has been revealed that Türkiye has a competitive advantage in these two products (HS Code 830710 and HS Code 841460). Due to RSCA>0 for the periods covering 2001-2021, it indicates that the product (HS Code 830710) has a comparative advantage. The other product (HS Code 841460) reveals the comparative advantage of the product, as the values calculated in other periods except 2001 are greater than zero. The fact that the TBI index is greater than zero throughout the periods reveals the net-exporter structure of the product (HS Code 830710). The other product (HS Code 841460) reveals the net-exporter structure of this product, since the calculated value is greater than zero in all periods except 2001. According to the product mapping method, the product (HS Code 830710) is in Group A, therefore it has been determined that Türkiye is a net-exporter (GROUP A) with a comparative advantage in the trade of this product. The product (841460) was included in Group D in 2001 and in Group A in other periods. In this context, it was revealed that it is a net-exporter (GROUP A) with a comparative advantage in the trade of this product.

Table 12. International competitiveness analysis for ventilation sub-product (2001-2021) (Compiled by authors).

	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2001	830710	1,57	1,58	0,47	1,11	0,53	0,22	0,49	Group A-RSCA>0, TBI>0
	841460	0,58	0,58	0,67	-0,09	-0,06	-0,27	-0,24	Group D-RSCA<0, TBI<0
2002	830710	1,27	1,28	0,53	0,75	0,38	0,12	0,33	Group A-RSCA>0, TBI>0
	841460	1,23	1,24	0,69	0,55	0,26	0,10	0,17	Group A-RSCA>0, TBI>0
2003	830710	1,83	1,86	0,70	1,16	0,42	0,29	0,29	Group A-RSCA>0, TBI>0
	841460	1,62	1,64	0,73	0,91	0,35	0,24	0,27	Group A-RSCA>0, TBI>0
2004	830710	3,06	3,13	0,96	2,17	0,51	0,51	0,42	Group A-RSCA>0, TBI>0
	841460	2,19	2,22	0,82	1,41	0,43	0,37	0,33	Group A-RSCA>0, TBI>0
2005	830710	3,08	3,15	0,56	2,58	0,75	0,51	0,61	Group A-RSCA>0, TBI>0
	841460	2,66	2,71	0,93	1,78	0,46	0,45	0,33	Group A-RSCA>0, TBI>0
2006	830710	3,79	3,89	0,44	3,45	0,95	0,58	0,69	Group A-RSCA>0, TBI>0
	841460	3,55	3,64	1,06	2,58	0,54	0,56	0,39	Group A-RSCA>0, TBI>0
2007	830710	3,39	3,48	0,45	3,03	0,89	0,54	0,71	Group A-RSCA>0, TBI>0
	841460	3,79	3,91	0,99	2,92	0,60	0,58	0,45	Group A-RSCA>0, TBI>0
2008	830710	3,42	3,53	0,51	3,02	0,84	0,55	0,73	Group A-RSCA>0, TBI>0
	841460	4,34	4,50	0,90	3,60	0,70	0,63	0,53	Group A-RSCA>0, TBI>0
2009	830710	3,78	3,90	0,53	3,38	0,87	0,58	0,71	Group A-RSCA>0, TBI>0
	841460	5,27	5,51	0,79	4,72	0,84	0,68	0,67	Group A-RSCA>0, TBI>0
2010	830710	3,31	3,40	0,53	2,86	0,80	0,54	0,62	Group A-RSCA>0, TBI>0
	841460	6,24	6,56	0,80	5,76	0,92	0,72	0,67	Group A-RSCA>0, TBI>0
2011	830710	3,99	4,12	0,58	3,53	0,85	0,60	0,60	Group A-RSCA>0, TBI>0
	841460	6,87	7,25	0,92	6,33	0,90	0,75	0,63	Group A-RSCA>0, TBI>0
2012	830710	3,37	3,47	0,84	2,62	0,61	0,54	0,49	Group A-RSCA>0, TBI>0
	841460	6,15	6,48	0,91	5,57	0,85	0,72	0,64	Group A-RSCA>0, TBI>0
2013	830710	4,70	4,90	0,98	3,92	0,70	0,65	0,56	Group A-RSCA>0, TBI>0
	841460	5,49	5,76	1,21	4,55	0,68	0,69	0,49	Group A-RSCA>0, TBI>0
2014	830710	3,95	4,09	1,28	2,81	0,51	0,60	0,43	Group A-RSCA>0, TBI>0
	841460	4,95	5,18	1,22	3,95	0,63	0,66	0,47	Group A-RSCA>0, TBI>0
2015	830710	1,47	1,49	1,55	-0,06	-0,02	0,19	0,22	Group A-RSCA>0, TBI>0
	841460	4,39	4,57	1,56	3,01	0,47	0,63	0,36	Group A-RSCA>0, TBI>0
2016	830710	1,44	1,46	1,22	0,24	0,08	0,18	0,32	Group A-RSCA>0, TBI>0
	841460	4,11	4,28	0,85	3,42	0,70	0,61	0,57	Group A-RSCA>0, TBI>0
2017	830710	1,71	1,73	1,21	0,53	0,16	0,26	0,32	Group A-RSCA>0, TBI>0
	841460	4,61	4,82	0,70	4,12	0,84	0,64	0,66	Group A-RSCA>0, TBI>0
2018	830710	1,39	1,41	0,85	0,56	0,22	0,16	0,24	Group A-RSCA>0, TBI>0
	841460	5,40	5,68	0,48	5,21	1,08	0,69	0,81	Group A-RSCA>0, TBI>0
2019	830710	1,38	1,40	0,39	1,01	0,55	0,16	0,50	Group A-RSCA>0, TBI>0
	841460	5,70	6,04	0,28	5,76	1,34	0,70	0,90	Group A-RSCA>0, TBI>0
2020	830710	4,41	4,61	0,94	3,67	0,69	0,63	0,48	Group A-RSCA>0, TBI>0
	841460	5,27	5,56	0,32	5,23	1,24	0,68	0,86	Group A-RSCA>0, TBI>0
2021	830710	4,22	4,41	0,92	3,49	0,68	0,62	0,58	Group A-RSCA>0, TBI>0
	841460	5,08	5,36	0,30	5,06	1,25	0,67	0,87	Group A-RSCA>0, TBI>0

Table 13-15 display the international competitiveness analysis results for the installation sub-product. It is comprehended that the RCA index values calculated for the products (HS Code 391731, HS Code 392111 and HS Code 741220) are 1 and above. The average value of the RCA index results was respectively calculated as 5.82, 1.51 and 2.84. The results are similar to the RXA index. Therefore, according to the results of these two indices, it has been determined that Türkiye has competitiveness in these products and shows specialization in exports. However, in the general evaluation of the RCA index analyzed for the other two products (HS Code 902511 and HS Code 902610), it is comprehended that the values are below one. The average values of RCA index and RXA index results were calculated as 0.28 and 0.17, respectively. Therefore, it has been revealed that Türkiye does not have competitiveness in these products and does not specialize in exports. In order for the RMP Index to gain competitive advantage in the relevant sector or product group, the calculated values necessitate to below one. In this context, the values calculated in the 2010 and 2012-2021 periods are less than 1, thus indicating the comparative advantage of the relevant product (HS Code 391731). The RMP index values calculated for the product (HS Code 741220) are below 1, in this context revealing the comparative advantage of the product. The analyzed values in the 2002-2007 and 2009 periods are overhead 1, which demonstrates the comparative disadvantage of the relevant product (HS Code 902511). The RMP index results calculated for the product (HS Code 902610) are above 1, revealing the comparative disadvantage of the relevant product. RTA and RC indices, which take both export and import aspects into consideration, will offer objective results. The index values analyzed for the products (HS Code 391721, HS Code 392111 and HS 741220) are positive. Therefore, it has been determined that Türkiye has a competitive advantage in these products. For other products (HS Code 902511 and HS Code 902610), the calculated values are negative. In this context, it has been revealed that Türkiye has a competitive disadvantage in these products. When evaluated in general, the RSCA index results calculated for the products (HS Code 391731, HS Code 392111 and HS Code 741220) are greater than zero, thus it indicates that Türkiye has a comparative advantage in these products. As RSCA<0, in the 2001-2021 periods, it reveals that the relevant products (HS Code 902511 and HS Code 902610) do not have a comparative advantage. The TBI index values calculated for the products (HS Code 391731, HS Code 392111 and HS Code 741220) are greater than zero, thus it reveals that the net-exporter structure of these products. The TBI index value analyzed for other products (HS Code 902511 and HS Code 902510) is less than zero, in this context Türkiye is in a net-importer structure for these products. According to the product mapping method, the products (HS Code 391731, HS Code 392111 and HS Code 7412220) are located in Group A. The explanation for this is that Türkiye has been a net-exporter (GROUP A) with a comparative advantage in the trade of these products. Generally evaluated, the products (HS Code 902511 and HS Code 902610) are in Group D. Hence, it has been revealed that Türkiye is a net-importer (GROUP D) with a comparative disadvantage in these products.

Table 13. International competitiveness analysis for installation sub-product (2001-2006) (Compiled by authors).

	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2001	391731	11,98	12,77	1,19	11,58	1,03	0,85	0,77	Group A-RSCA>0, TBI>0
	392111	1,25	1,26	0,23	1,03	0,73	0,11	0,63	Group A-RSCA>0, TBI>0
	741220	0,54	0,54	0,29	0,25	0,27	-0,30	0,13	Group C-RSCA<0, TBI>0
	902511	0,15	0,15	0,76	-0,61	-0,70	-0,74	-0,74	Group D-RSCA<0, TBI<0
	902610	0,09	0,09	1,02	-0,93	-1,06	-0,84	-0,89	Group D-RSCA<0, TBI<0
2002	391731	2,30	2,33	1,16	1,17	0,30	0,39	0,12	Group A-RSCA>0, TBI>0
	392111	1,39	1,40	0,10	1,30	1,14	0,16	0,82	Group A-RSCA>0, TBI>0
	741220	1,20	1,21	0,30	0,91	0,60	0,09	0,41	Group A-RSCA>0, TBI>0
	902511	0,27	0,27	1,16	-0,89	-0,63	-0,58	-0,74	Group D-RSCA<0, TBI<0
	902610	0,08	0,08	0,93	-0,85	-1,07	-0,85	-0,90	Group D-RSCA<0, TBI<0
2003	391731	2,46	2,50	1,32	1,18	0,28	0,42	0,13	Group A-RSCA>0, TBI>0
	392111	0,72	0,73	0,08	0,65	0,94	-0,16	0,72	Group C-RSCA<0, TBI>0
	741220	1,66	1,68	0,27	1,41	0,79	0,25	0,58	Group A-RSCA>0, TBI>0
	902511	0,24	0,24	1,14	-0,90	-0,68	-0,61	-0,77	Group D-RSCA<0, TBI<0
	902610	0,10	0,10	1,01	-0,91	-1,01	-0,82	-0,88	Group D-RSCA<0, TBI<0
2004	391731	3,99	4,11	1,53	2,58	0,43	0,60	0,25	Group A-RSCA>0, TBI>0
	392111	0,76	0,77	0,05	0,72	1,16	-0,13	0,81	Group C-RSCA<0, TBI>0
	741220	1,38	1,40	0,38	1,01	0,56	0,16	0,39	Group A-RSCA>0, TBI>0
	902511	0,21	0,21	1,15	-0,93	-0,73	-0,65	-0,82	Group D-RSCA<0, TBI<0
	902610	0,13	0,13	0,84	-0,71	-0,80	-0,77	-0,90	Group D-RSCA<0, TBI<0
2005	391731	8,49	9,03	1,45	7,59	0,80	0,79	0,53	Group A-RSCA>0, TBI>0
	392111	0,99	1,00	0,13	0,87	0,90	-0,01	0,68	Group C-RSCA<0, TBI>0
	741220	1,44	1,45	0,39	1,06	0,57	0,18	0,39	Group A-RSCA>0, TBI>0
	902511	0,46	0,46	1,75	-1,29	-0,58	-0,37	-0,75	Group D-RSCA<0, TBI<0
	902610	0,12	0,12	0,92	-0,80	-0,88	-0,78	-0,85	Group D-RSCA<0, TBI<0
2006	391731	9,13	9,77	1,16	8,61	0,93	0,80	0,62	Group A-RSCA>0, TBI>0
	392111	1,52	1,54	0,16	1,38	0,98	0,21	0,72	Group A-RSCA>0, TBI>0
	741220	1,99	2,02	0,59	1,43	0,53	0,33	0,36	Group A-RSCA>0, TBI>0
	902511	0,33	0,34	1,34	-1,00	-0,60	-0,50	-0,77	Group D-RSCA<0, TBI<0
	902610	0,11	0,11	1,07	-0,96	-0,97	-0,80	-0,88	Group D-RSCA<0, TBI<0

Table 14. International competitiveness analysis for installation sub-product (2007-2019) (Compiled by authors).

	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
	391731	7,28	7,71	1,26	6,46	0,79	0,76	0,55	Group A-RSCA>0, TBI>0
	392111	1,55	1,57	0,05	1,52	1,50	0,22	0,91	Group A-RSCA>0, TBI>0
2007	741220	2,19	2,23	0,68	1,55	0,51	0,37	0,32	Group A-RSCA>0, TBI>0
	902511	0,36	0,36	1,20	-0,84	-0,52	-0,47	-0,74	Group D-RSCA<0, TBI<0
	902610	0,13	0,13	1,15	-1,02	-0,93	-0,76	-0,86	Group D-RSCA<0, TBI<0
	391731	8,27	8,88	1,24	7,63	0,85	0,78	0,58	Group A-RSCA>0, TBI>0
	392111	1,10	1,11	0,08	1,03	1,13	0,05	0,80	Group A-RSCA>0, TBI>0
2008	741220	2,36	2,41	0,66	1,75	0,56	0,40	0,40	Group A-RSCA>0, TBI>0
	902511	0,21	0,21	0,93	-0,72	-0,65	-0,65	-0,79	Group D-RSCA<0, TBI<0
	902610	0,14	0,14	1,23	-1,09	-0,95	-0,76	-0,86	Group D-RSCA<0, TBI<0
	391731	6,87	7,28	1,04	6,24	0,84	0,75	0,66	Group A-RSCA>0, TBI>0
	392111	0,73	0,74	0,11	0,63	0,82	-0,15	0,67	Group C-RSCA<0, TBI>0
2009	741220	2,36	2,41	0,41	2,00	0,77	0,41	0,60	Group A-RSCA>0, TBI>0
	902511	0,24	0,25	1,33	-1,09	-0,74	-0,61	-0,80	Group D-RSCA<0, TBI<0
	902610	0,13	0,14	1,16	-1,02	-0,93	-0,76	-0,84	Group D-RSCA<0, TBI<0
	391731	8,15	8,69	0,78	7,91	1,05	0,78	0,76	Group A-RSCA>0, TBI>0
	392111	0,79	0,80	0,44	0,36	0,26	-0,12	0,11	Group C-RSCA<0, TBI>0
2010	741220	2,96	3,03	0,46	2,57	0,82	0,50	0,59	Group A-RSCA>0, TBI>0
	902511	0,16	0,16	0,65	-0,49	-0,62	-0,73	-0,77	Group D-RSCA<0, TBI<0
	902610	0,16	0,16	1,03	-0,88	-0,82	-0,73	-0,83	Group D-RSCA<0, TBI<0
	391731	7,63	8,09	1,37	6,72	0,77	0,77	0,56	Group A-RSCA>0, TBI>0
	392111	1,03	1,03	0,23	0,80	0,65	0,01	0,46	Group A-RSCA>0, TBI>0
2011	741220	3,19	3,27	0,51	2,75	0,80	0,52	0,53	Group A-RSCA>0, TBI>0
	902511	0,19	0,19	0,54	-0,36	-0,46	-0,69	-0,72	Group D-RSCA<0, TBI<0
	902610	0,18	0,18	1,06	-0,88	-0,77	-0,69	-0,83	Group D-RSCA<0, TBI<0
	391731	8,36	8,99	0,69	8,31	1,12	0,79	0,78	Group A-RSCA>0, TBI>0
	392111	1,22	1,23	0,11	1,12	1,04	0,10	0,77	Group A-RSCA>0, TBI>0
2012	741220	3,26	3,35	0,54	2,81	0,79	0,53	0,58	Group A-RSCA>0, TBI>0
	902511	0,29	0,29	0,60	-0,31	-0,32	-0,55	-0,64	Group D-RSCA<0, TBI<0
	902610	0,17	0,17	0,91	-0,74	-0,72	-0,71	-0,79	Group D-RSCA<0, TBI<0
	391731	7,02	7,47	0,57	6,91	1,12	0,75	0,78	Group A-RSCA>0, TBI>0
	392111	1,42	1,44	0,15	1,29	0,97	0,17	0,72	Group A-RSCA>0, TBI>0
2013	741220	3,85	3,99	0,54	3,45	0,87	0,59	0,62	Group A-RSCA>0, TBI>0
	902511	0,32	0,32	0,53	-0,21	-0,22	-0,52	-0,53	Group D-RSCA<0, TBI<0
	902610	0,17	0,17	0,80	-0,63	-0,68	-0,71	-0,78	Group D-RSCA<0, TBI<0
	391731	6,44	6,83	0,63	6,21	1,04	0,73	0,75	Group A-RSCA>0, TBI>0
	392111	2,10	2,14	0,10	2,04	1,32	0,36	0,87	Group A-RSCA>0, TBI>0
2014	741220	3,95	4,09	0,53	3,56	0,89	0,60	0,66	Group A-RSCA>0, TBI>0
	902511	0,16	0,16	0,60	-0,44	-0,58	-0,73	-0,73	Group D-RSCA<0, TBI<0
	902610	0,22	0,22	0,89	-0,66	-0,60	-0,64	-0,72	Group D-RSCA<0, TBI<0
	391731	4,98	5,22	0,64	4,58	0,91	0,67	0,71	Group A-RSCA>0, TBI>0
	392111	2,40	2,45	0,12	2,33	1,30	0,41	0,87	Group A-RSCA>0, TBI>0
2015	741220	3,67	3,81	0,59	3,22	0,81	0,57	0,64	Group A-RSCA>0, TBI>0
	902511	0,14	0,14	0,69	-0,55	-0,69	-0,75	-0,74	Group D-RSCA<0, TBI<0
	902610	0,17	0,17	1,16	-0,98	-0,82	-0,70	-0,81	Group D-RSCA<0, TBI<0
	391731	4,01	4,17	0,67	3,50	0,79	0,60	0,66	Group A-RSCA>0, TBI>0
	392111	1,95	1,99	0,17	1,82	1,07	0,32	0,80	Group A-RSCA>0, TBI>0
2016	741220	3,49	3,61	0,51	3,11	0,85	0,55	0,66	Group A-RSCA>0, TBI>0
	902511	0,20	0,20	0,68	-0,48	-0,54	-0,67	-0,64	Group D-RSCA<0, TBI<0
	902610	0,16	0,16	1,20	-1,04	-0,87	-0,72	-0,82	Group D-RSCA<0, TBI<0
	391731	1,78	1,81	0,76	1,05	0,38	0,28	0,54	Group A-RSCA>0, TBI>0
	392111	1,91	1,95	0,15	1,80	1,10	0,31	0,80	Group A-RSCA>0, TBI>0
2017	741220	3,79	3,93	0,44	3,49	0,95	0,58	0,70	Group A-RSCA>0, TBI>0
	902511	0,15	0,15	0,53	-0,38	-0,56	-0,75	-0,70	Group D-RSCA<0, TBI<0
	902610	0,19	0,19	1,17	-0,99	-0,80	-0,69	-0,80	Group D-RSCA<0, TBI<0
	391731	3,08	3,17	0,98	2,19	0,51	0,51	0,47	Group A-RSCA>0, TBI>0
	392111	2,07	2,12	0,12	1,99	1,23	0,35	0,86	Group A-RSCA>0, TBI>0
2018	741220	4,09	4,26	0,44	3,82	0,99	0,61	0,75	Group A-RSCA>0, TBI>0
	902511	0,22	0,22	0,35	-0,13	-0,21	-0,64	-0,43	Group D-RSCA<0, TBI<0
	902610	0,20	0,20	0,94	-0,74	-0,68	-0,67	-0,71	Group D-RSCA<0, TBI<0
	391731	3,14	3,24	0,99	2,24	0,51	0,52	0,52	Group A-RSCA>0, TBI>0
	392111	2,31	2,36	0,11	2,25	1,35	0,40	0,90	Group A-RSCA>0, TBI>0
2019	741220	3,96	4,12	0,54	3,57	0,88	0,60	0,71	Group A-RSCA>0, TBI>0
	902511	0,79	0,80	0,47	0,33	0,24	-0,11	0,20	Group C-RSCA<0, TBI>0
	902610	0,23	0,23	1,02	-0,79	-0,64	-0,62	-0,66	Group D-RSCA<0, TBI<0

Table 15. International competitiveness analysis for installation sub-product (2020-2021) (Compiled by authors).

	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
2020	391731	3,35	3,47	0,64	2,83	0,73	0,54	0,65	Group A-RSCA>0, TBI>0
	392111	2,31	2,36	0,06	2,30	1,60	0,39	0,94	Group A-RSCA>0, TBI>0
	741220	4,25	4,44	0,62	3,81	0,85	0,62	0,67	Group A-RSCA>0, TBI>0
	902511	0,34	0,34	0,31	0,03	0,04	-0,49	-0,32	Group D-RSCA<0, TBI<0
	902610	0,33	0,33	0,92	-0,59	-0,44	-0,50	-0,56	Group D-RSCA<0, TBI<0
2021	391731	3,43	3,55	0,58	2,97	0,79	0,55	0,71	Group A-RSCA>0, TBI>0
	392111	2,11	2,16	0,05	2,11	1,61	0,36	0,94	Group A-RSCA>0, TBI>0
	741220	4,01	4,19	0,58	3,61	0,86	0,60	0,69	Group A-RSCA>0, TBI>0
	902511	0,38	0,38	0,36	0,01	0,02	-0,45	-0,13	Group D-RSCA<0, TBI<0
	902610	0,28	0,28	1,01	-0,74	-0,56	-0,57	-0,63	Group D-RSCA<0, TBI<0

Table 16 demonstrates the international competitiveness analysis results for the insulation sub-product. The RCA index values calculated for the product (HS Code 400819) are overhead 1. These index values were at high levels in 2001 and 2002. The average value of the RCA index was calculated as 4.89 and the average value of the RXA index was calculated as 5.25. Therefore, it was determined that Türkiye has competitiveness in this product and shows specialization in exports. The RCA index values calculated for the product (HS Code 701939) are above 1 in the 2015-2021 periods and its competitiveness is at the limit. However, the RCA index calculated for the product (HS Code 680610) values are below 1 in all periods except the 2018 and 2021 periods. The average value of the RCA index was calculated as 0.80 Therefore, it has been revealed that Türkiye does not have competitiveness in this product and does not specialize in exports. In order for the RMP Index to gain competitive advantage in the relevant sector or product group, the calculated values require to below one. Although there are fluctuations from time to time, the RMP index values calculated for the products (HS Code 400819 and HS Code 680610) are recorded as 1 and above. Hence, it indicates the import surplus of these products. The RMP index values analyzed for the product with limit competitiveness (HS Code 701939) are below 1, in this context indicating that the import of the product is decrease. RTA and RC indices, which take both export and import aspects into consideration, will provide objective results. These index values calculated for products (HS Code 40819 and HS Code 701939) are positive. In this context, these products reveal that Türkiye's competitive advantage. The analyzed values for the other product (HS Code 680610) are negative. Therefore, it has been determined that Türkiye has a competitive disadvantage in this product. The RSCA index values calculated for the product (HS Code 400819) in the 2001-2021 periods are greater than zero, which point outs that the product has a comparative advantage. The RSCA index values analyzed for the product (HS Code 701939) in the 2015-2021 periods are bigger than zero, therefore it has been revealed that the product has a comparative advantage in these periods. As for the other product (HS Code 680610), the RSCA index values calculated in the 2001-2021 periods are less than zero, indicating that Türkiye does not have a comparative advantage in this product. The TBI index values calculated for the product (HS Code 400819) are greater than zero, thus revealing the net-exporter of the product. The TBI index values calculated for the product (HS Code 680610) in the 2001-2021 periods are less than zero, which highlights the net-importer of the product. The average value of the TBI index for the product (HS Code 701939) was recorded as 0.21, which reveals the net-exporter of the relevant product. According to the Product Mapping method, the product (HS Code 400819) is in Group A. Hence, Türkiye is a net-exporter (GROUP A) with a comparative advantage in the trade of this product. The product (HS Code 680610) is in Group D and this product reveals a net-importer with a comparative disadvantage. Only this product (HS Code 701939) is included in Group C. Therefore, it has been determined that this product has a comparative disadvantage but is in a net-exporter.

Grounded on the RSCA and TBI results and by the Cartesian coordinate system, the place of both the air conditioning sector and its sub-product group in the product map was determined and its place in foreign trade was revealed. In the product mapping created for both the air conditioning sector and sub-product groups, the years (2001, 2008, 2012, 2021 and on average) were selected randomly. In this context, the results of the air conditioning sector and sub-product group product map for 2001 are highlighted in Figure 2. In 2001, the air conditioning industry was included in Group D in product mapping. Thus, it has been determined that Türkiye has no comparative advantage in the air conditioning industry and is a net-importer. In 2001, products HS Code 732181, HS Code 392111, HS Code 830710, HS Code 732211, HS Code 400819 and HS Code 391731 were included in Group A. It is realized that our country had competitiveness in these products in 2001 and was a net-exporter. Products with HS Code 721220, HS Code 701939 and HS Code 840310 are in Group C. Therefore, it does not have a comparative advantage in these three products, but it reveals its net- exporter. HS Code 841850, HS Code 841460, HS Code 841490, HS Code 680610, HS Code 851610, HS Code 841610, HS Code 902511, HS Code 841891, HS Code 841430, HS Code 841939, HS Code 841989, HS Code 841520, HS Code 840220 and HS Code 902610 were classified as Group D in the product mapping in 2001. In this context, it is comprehended that Türkiye does not have a comparative advantage in the 14 products listed and is a net-importer**.** When evaluated in terms of the 2001 crisis, it is comprehended that the air conditioning industry and 14 products are in Group D. Türkiye has a trade deficit in air conditioning trade in this period.

Table 16. International competitiveness analysis for insulation sub-product (Compiled by authors).

	HS Code	RCA	RXA	RMP	RTA	RC	TBI	RSCA	Product mapping
	400819	25,63	29,50	0,97	28,53	1,48	0,92	0,93	GroupA-RSCA>0, TBI>0
2001	680610	0,63	0,63	0,96	-0,33	-0,18	-0,23	-0,40	Group D-RSCA<0, TBI<0
	701939	0,30	0,30	0,17	0,13	0,25	-0,54	0,18	Group C-RSCA<0, TBI>0
	400819	16,84	18,59	0,73	17,86	1,40	0,89	0,92	Group A-RSCA>0, TBI>0
2002	680610	0,82	0,83	2,09	-1,26	-0,40	-0,10	-0,59	Group D-RSCA<0, TBI<0
	701939	0,59	0,59	0,27	0,32	0,33	-0,26	0,24	Group C-RSCA<0, TBI>0
	400819	4,77	4,92	1,52	3,40	0,51	0,65	0,49	Group A-RSCA>0, TBI>0
2003	680610	0,90	0,90	0,96	-0,05	-0,03	-0,05	-0,21	Group D-RSCA<0, TBI<0
	701939	0,57	0,57	0,31	0,26	0,27	-0,28	0,18	Group C-RSCA<0, TBI>0
	400819	1,59	1,61	1,47	0,14	0,04	0,23	-0,05	Group B-RSCA>0, TBI<0
2004	680610	0,73	0,73	1,09	-0,36	-0,17	-0,16	-0,37	Group D-RSCA<0, TBI<0
	701939	0,68	0,69	0,40	0,29	0,23	-0,19	0,11	Group C-RSCA<0, TBI>0
	400819	1,51	1,52	1,12	0,40	0,13	0,20	0,02	Group A-RSCA>0, TBI>0
2005	680610	0,96	0,96	0,82	0,15	0,07	-0,02	-0,17	Group D-RSCA<0, TBI<0
	701939	0,58	0,58	0,37	0,21	0,19	-0,27	0,10	Group C-RSCA<0, TBI>0
	400819	2,54	2,59	0,88	1,71	0,47	0,43	0,37	Group A-RSCA>0, TBI>0
2006	680610	0,76	0,76	1,02	-0,25	-0,12	-0,14	-0,37	Group D-RSCA<0, TBI<0
	701939	0,38	0,38	0,26	0,11	0,16	-0,45	0,04	Group C-RSCA<0, TBI>0
	400819	2,92	2,98	1,22	1,77	0,39	0,49	0,34	Group A-RSCA>0, TBI>0
2007	680610	0,85	0,86	0,49	0,37	0,24	-0,08	-0,17	Group D-RSCA<0, TBI<0
	701939	0,31	0,31	0,35	-0,04	-0,05	-0,53	-0,14	Group D-RSCA<0, TBI<0
	400819	2,29	2,34	1,67	0,66	0,14	0,39	0,05	Group A-RSCA>0, TBI>0
2008	680610	0,60	0,60	0,87	-0,27	-0,16	-0,25	-0,39	Group D-RSCA<0, TBI<0
	701939	0,21	0,21	0,51	-0,30	-0,38	-0,66	-0,52	Group D-RSCA<0, TBI<0
	400819	1,98	2,01	1,36	0,65	0,17	0,33	0,16	Group A-RSCA>0, TBI>0
2009	680610	0,81	0,81	0,83	-0,01	-0,01	-0,11	-0,17	Group D-RSCA<0, TBI<0
	701939	0,70	0,70	0,45	0,26	0,20	-0,18	0,20	Group C-RSCA<0, TBI>0
	400819	3,12	3,19	0,98	2,21	0,51	0,51	0,45	Group A-RSCA>0, TBI>0
2010	680610	0,96	0,97	1,01	-0,04	-0,02	-0,02	-0,29	Group D-RSCA<0, TBI<0
	701939	0,81	0,81	0,51	0,31	0,21	-0,11	0,05	Group C-RSCA<0, TBI>0
	400819	4,20	4,33	0,90	3,43	0,68	0,62	0,53	Group A-RSCA>0, TBI>0
2011	680610	0,75	0,76	1,09	-0,33	-0,16	-0,14	-0,46	Group D-RSCA<0, TBI<0
	701939	0,74	0,74	0,44	0,30	0,22	-0,15	0,02	Group C-RSCA<0, TBI>0
	400819	4,13	4,28	0,81	3,47	0,72	0,61	0,55	Group A-RSCA>0, TBI>0
2012	680610	0,78	0,78	1,11	-0,33	-0,15	-0,13	-0,38	Group D-RSCA<0, TBI<0
	701939	0,92	0,93	0,42	0,51	0,35	-0,04	0,27	Group C-RSCA<0, TBI>0
	400819	5,82	6,13	1,26	4,87	0,69	0,71	0,45	Group A-RSCA>0, TBI>0
2013	680610	0,84	0,84	1,05	-0,21	-0,10	-0,09	-0,36	Group D-RSCA<0, TBI<0
	701939	0,91	0,91	0,50	0,42	0,26	-0,05	0,12	Group C-RSCA<0, TBI>0
	400819	4,40	4,58	0,89	3,69	0,71	0,63	0,53	Group A-RSCA>0, TBI>0
2014	680610	0,69	0,69	1,32	-0,63	-0,28	-0,18	-0,50	Group D-RSCA<0, TBI<0
	701939	0,98	0,99	0,64	0,35	0,19	-0,01	0,07	Group C-RSCA<0, TBI>0
	400819	4,03	4,19	0,48	3,71	0,94	0,60	0,70	Group A-RSCA>0, TBI>0
2015	680610	0,70	0,71	1,17	-0,46	-0,22	-0,18	-0,40	Group D-RSCA<0, TBI<0
	701939	1,55	1,57	0,42	1,15	0,57	0,22	0,49	Group A-RSCA>0, TBI>0
	400819	4,20	4,38	0,89	3,49	0,69	0,62	0,50	Group A-RSCA>0, TBI>0
2016	680610	0,66	0,66	1,01	-0,35	-0,19	-0,21	-0,36	Group D-RSCA<0, TBI<0
	701939	1,74	1,77	0,34	1,42	0,71	0,27	0,59	Group A-RSCA>0, TBI>0
	400819	2,75	2,82	0,92	1,89	0,48	0,47	0,24	Group A-RSCA>0, TBI>0
2017	680610	0,56	0,57	0,99	-0,43	-0,24	-0,28	-0,46	Group D-RSCA<0, TBI<0
	701939	1,78	1,81	0,32	1,49	0,75	0,28	0,60	Group A-RSCA>0, TBI>0
	400819	2,98	3,06	0,67	2,39	0,66	0,50	0,49	Group A-RSCA>0, TBI>0
2018	680610	1,00	1,01	0,97	0,05	0,02	0,00	-0,12	Group B-RSCA>0, TBI<0
	701939	2,29	2,34	0,42	1,92	0,75	0,39	0,63	Group A-RSCA>0, TBI>0
	400819	2,32	2,38	0,81	1,57	0,47	0,40	0,38	Group A-RSCA>0, TBI>0
2019	680610	0,72	0,72	0,91	-0,18	-0,10	-0,16	-0,19	Group D-RSCA<0, TBI<0
	701939	1,99	2,03	0,73	1,29	0,44	0,33	0,42	Group A-RSCA>0, TBI>0
	400819	2,35	2,40	1,09	1,31	0,34	0,40	0,20	Group A-RSCA>0, TBI>0
2020	680610	0,57	0,57	0,68	-0,11	-0,07	-0,27	-0,23	Group D-RSCA<0, TBI<0
	701939	1,99	2,03	0,67	1,37	0,48	0,33	0,42	Group A-RSCA>0, TBI>0
	400819	2,36	2,42	0,79	1,63	0,48	0,41	0,36	Group A-RSCA>0, TBI>0
2021	680610	1,48	1,50	0,69	0,82	0,34	0,19	0,28	Group A-RSCA>0, TBI>0
	701939	1,90	1,94	0,89	1,04	0,34	0,31	0,31	Group A-RSCA>0, TBI>0

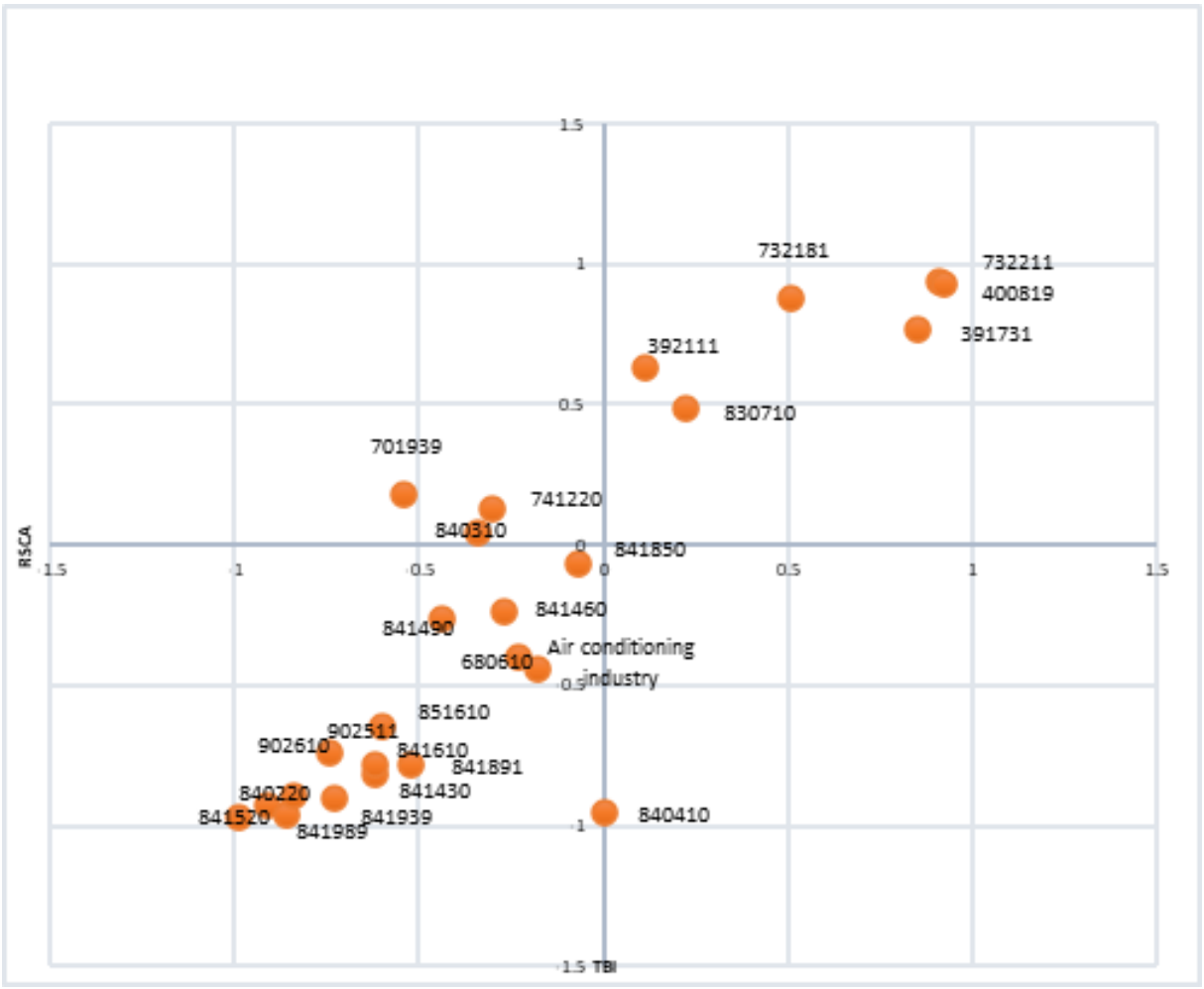

Figure 2. Product mapping for 2001.

Figure 3 displays the product map results of the air conditioning sector and sub-product group for 2008. In 2008, the air conditioning sector was included in Group B in the product map. It has been determined that Türkiye has a comparative advantage in the air conditioning sector but is a net-importer. Likewise, products HS Code 840310 and HS Code 840410 are included in Group B. Products with HS Code 841891 and HS Code 841490 codes are located in Group C on the product map in 2008. Therefore, it is realized that these two products do not have a comparative advantage but are included in the net-exporter. Compared to 2001, the number of products in Group D has decreased. In this context, HS Code 851610, HS Code 680610, HS Code 841610, HS Code 701939, HS Code 902610, HS Code 840220, Products with HS Code 902511, HS Code 841989, HS Code 841430 and HS Code 841939 are located in Group D on the product map in 2008. In this context, it has been revealed that Türkiye does not have a comparative advantage in these 10 products and is a net-importer. When the 2008 Global Crisis is assessed from an economic perspective, it can be comprehended that the air conditioning industry is included in Group B and 10 products are involved in Group A. Therefore, it has been concluded that the air conditioning industry maintains its competitive structure despite the crisis period.

Figure 4 indicates the product mapping results of the air conditioning sector and sub-product group for 2012. According to the product mapping results of the air conditioning sector, it is involved in Group B. The explanation for this is that Türkiye has a comparative advantage in the air conditioning trade but is a net importer. The other product in Group B is HS Code 841939. HS Code 732211, HS Code 841850, HS Code 732181, HS Code 392111, HS Code 841891, HS Code 741220, HS Code 830710, HS Code 400819, HS Code 841460, HS Products numbered Code 391731, HS Code 840310, HS Code 841850 are included in Group A. Thus, Türkiye has both a comparative advantage and a net exporter position in the trade of these 11 products. Products with codes HS Code 841610, HS Code 841490 and HS Code 701939 are involved in Group C. In this context, this study revealed that Türkiye does not have a comparative advantage in these three products but is a net exporter. Products with codes HS Code 680610, HS Code 841520, HS Code 851610, HS Code 841439, HS Code 841430, HS Code 902610, HS Code 902511 and HS Code 840220 are included in Group D. It has been determined that Türkiye is a net importer with comparative disadvantage in these 8 products. In 2012, the HS Code 840410 product was positioned on the vertical axis between Group B and Group C. In this context, the relevant product does not have a comparative advantage since it is located on the southern axis.

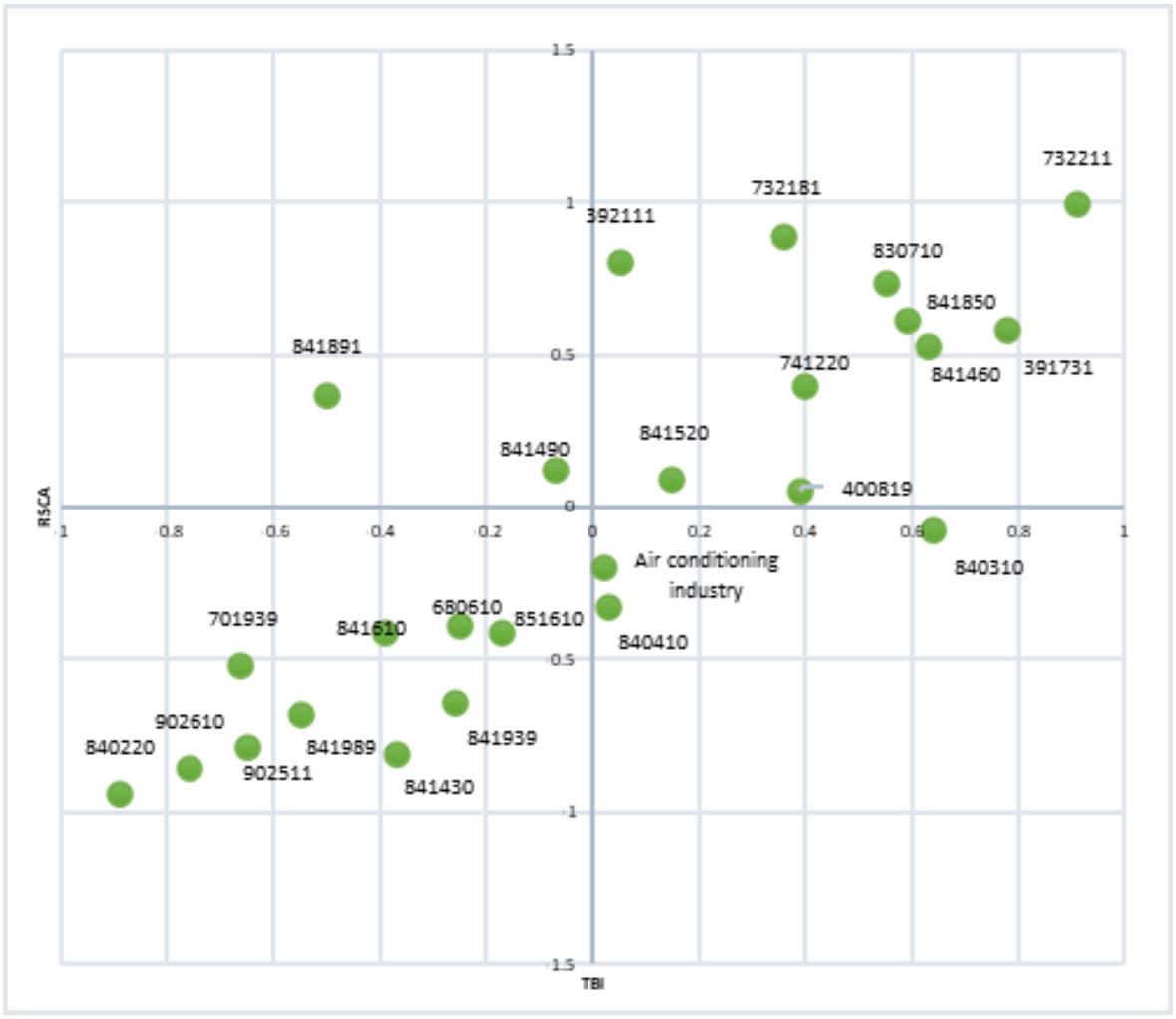

Figure 3. Product mapping for 2008.

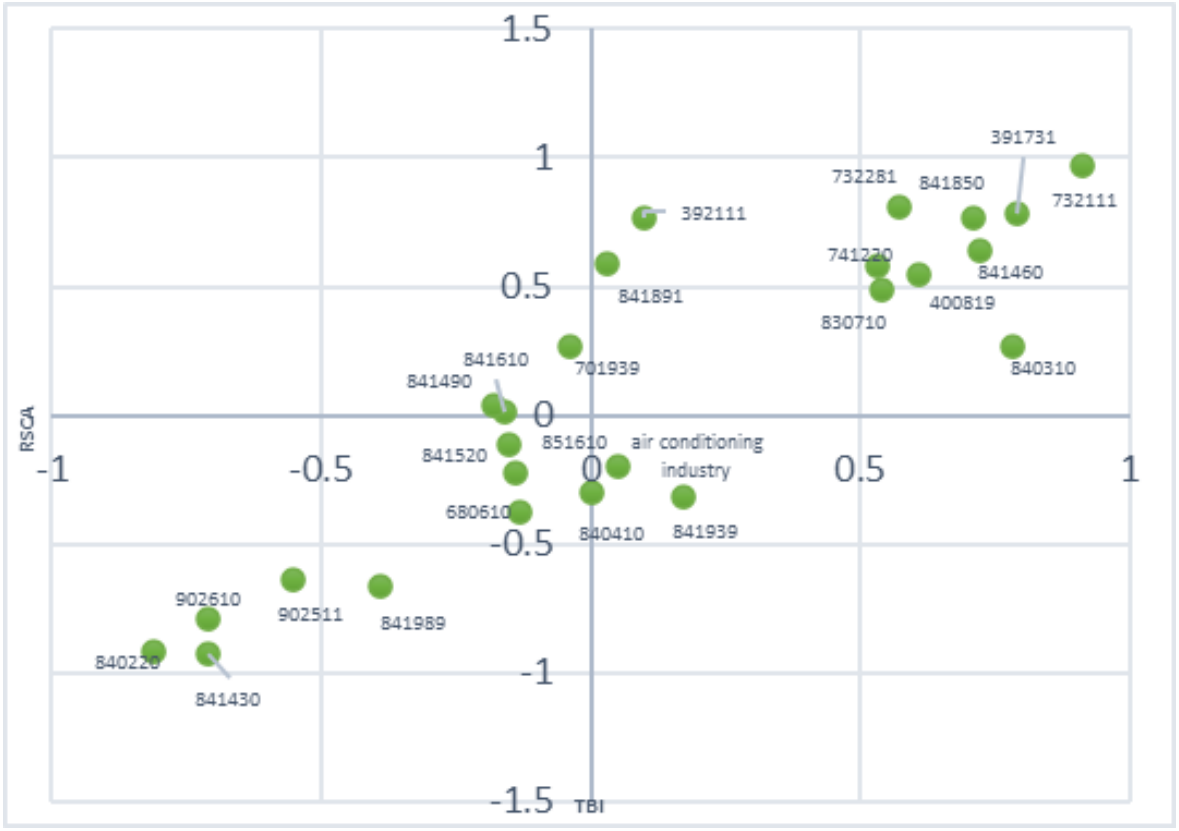

Figure 4. Product mapping for 2012.

Figure 5 indicates the product mapping results of the air conditioning sector and sub-product group for 2021. In 2021, the air conditioning sector is in Group B in product mapping. Therefore, it has been revealed that the sector has a comparative advantage but is in a net-importer. When the results of Türkiye's product mapping of 2001, 2008 and 2012 are compared, it can be realized in Figure 5 that the number of products in Group A increased in 2021. HS Code 732181, HS Code 392111, HS Code 841610, HS Code 680610, HS Code 701939, HS Code 841939, HS Code 400819, HS Code 830710, HS Code 840310, HS Code 841891, HS Code 391731, HS Code 741220 HS Code 841850, HS Code 732211 and HS Code 841460 products are included in Group A in the 2021 product mapping. In this context, it has been determined that Türkiye has a comparative advantage in these 15 products and is also a net-exporter. HS Code 841490 and HS Code 841410 products are included in Group C in the product mapping in 2021, therefore it is realized that these two products do not have a comparative advantage but are in a net-exporter. The number of products in Group D decreased in 2021. In this context, products coded HS Code 841520, HS Code 851610, HS Code 902511, HS Code 902610, HS Code 840220, HS Code 841430 and HS Code 841989 are included in Group D in product mapping in 2021. Therefore, Türkiye does not have a comparative advantage in these 7 products and is a net-importer. When evaluated in terms of the impact of the 2021 Foreign Exchange and Debt Crisis and the Covid-19 pandemic, it is comprehended that the air conditioning s industry is in Group B and 15 products are in Group A. Hence, it has been observed that the air conditioning industry maintains its competitive structure despite periods of crisis.

The average product mapping results of the air conditioning sector and sub-product group for the periods 2001-2021 are highlighted in Figure 6. According to the product mapping results, the air conditioning sector is in Group B. The explanation for this is that it has a comparative advantage however a net-importer is. HS Code 732211, HS Code 841850, HS Code 732181, HS Code 392111, HS Code 841891, HS Code 741220, HS Code 830710, HS Code 400819, HS Code 841460, HS Code 391731, HS Code 840310, HS Code 841850 products are included in Group A. Türkiye has both a comparative advantage and a net-exporter in the trade of these 11 products. Only the product with HS Code 701939 is included in Group C. This study revealed that Türkiye does not have a comparative advantage in this product, but is a net-exporter. HS Code 841490, HS Code 841610, HS Code 680610, HS Code 841520, HS Code 840410, HS Code 841939, HS Code 851610, HS Code 841439, HS Code 841430, HS Code 902610, HS Code 902511 and HS Code 840220, products are included in Group D. It has been concluded that Türkiye is a net- importer with comparative disadvantage in these 12 products.

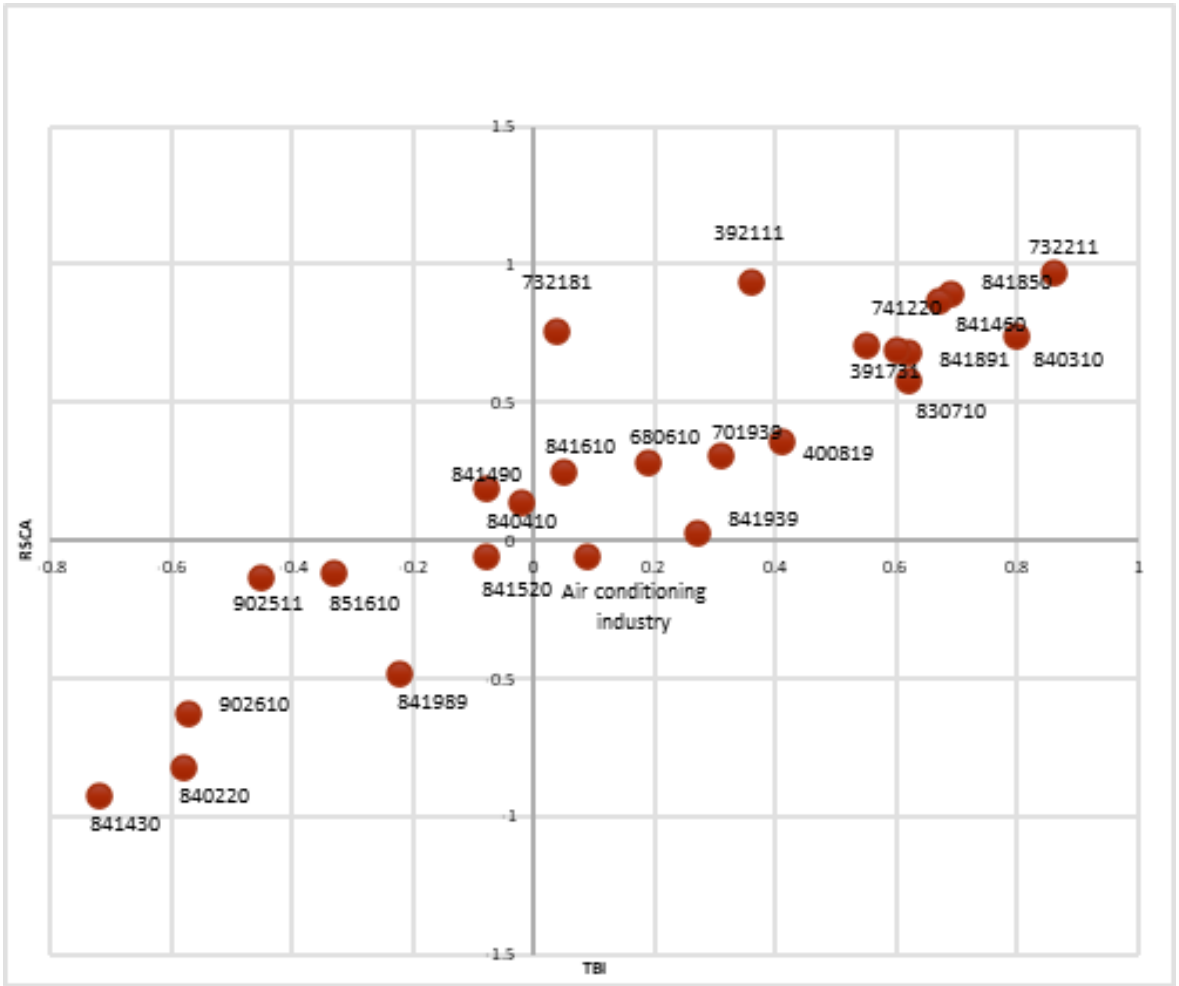

Figure 5. Product mapping for 2021.

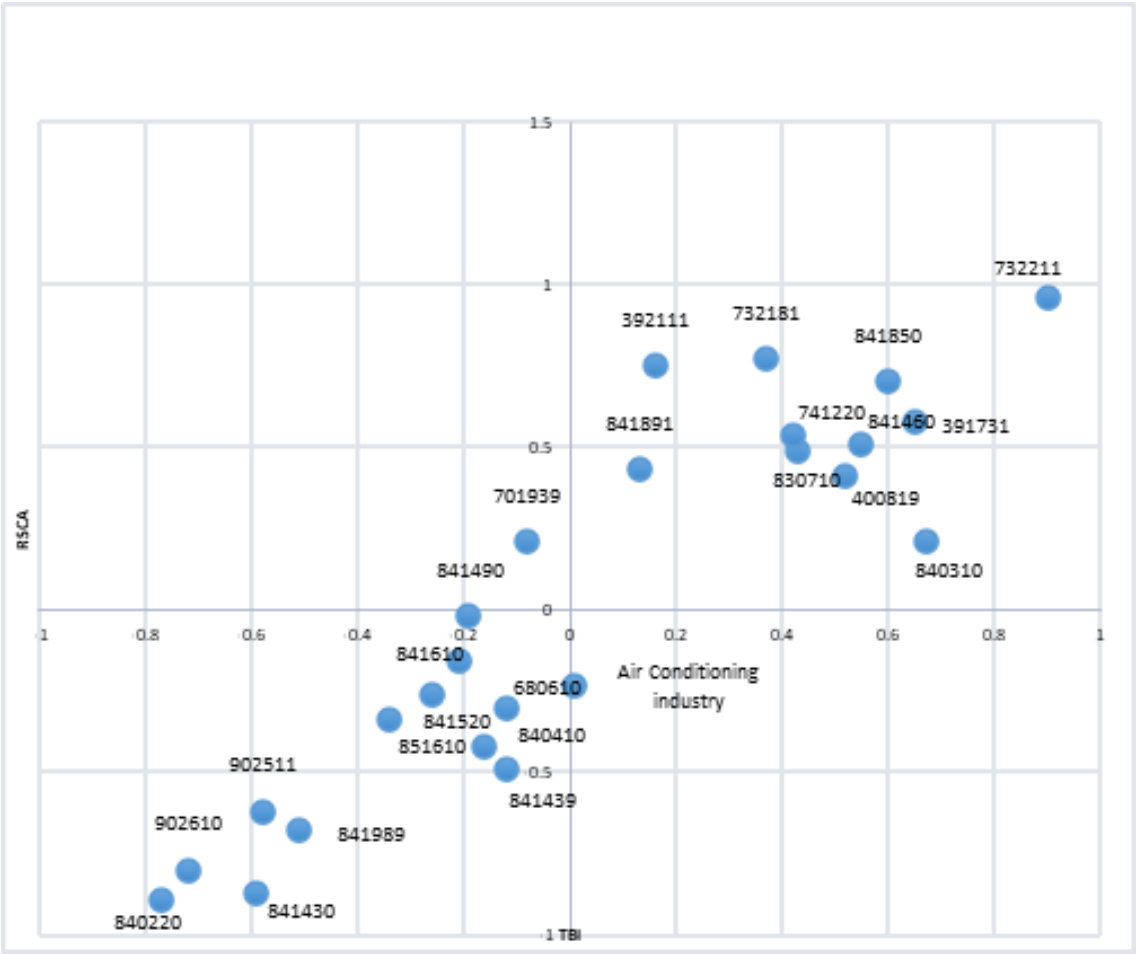

Figure 6. Average product mapping for the period of 2001-2021.

6. Conclusion and recommendations

Türkiye ranks 19th in global air conditioning exports and its share in world air conditioning exports is 3% [18]. Türkiye's air conditioning exports in 2022 amounted to 6 billion 680 million dollars. The number of companies operating in the air conditioning sector in 2022 is 20 thousand 762 [51]. The fact that the air conditioning sector has become a significant sector nowadays and in the future was an important factor in the creation of the study and was deemed suitable for research. In this context, the aim of the study is to research the international competitiveness of the Turkish air conditioning industry and its sub-product groups (heating, refrigeration, air conditioning, ventilation, installation and insulation) for the periods 2001-2021. In this study, Balassa's Revealed Comparative Advantage Index (RCA), Vollrath Indices (RXA, RMP, RTA, RC), Revealed Symmetric Comparative Advantage Index (RSCA), Trade Balance Index (TBI) and Product Mapping method were used. Turkish literature using the product mapping method is extremely limited [26-32]. Studies in the international literature on product mapping method are [33-39].

The contributions of this study to the literature are summarized. Alterations in specialization in the trade of the air conditioning sector and its sub-product group have been identified, products and sector with competitiveness have been revealed, and the mobility of the comparative advantage of the sector and sub-product group has been analyzed. Product mapping has been consisted of the first time in the literature for the air conditioning sector and its sub-product groups. According to the study findings, the average values of the RCA and RXA index results calculated in the 2001-2021 periods of the Turkish air conditioning industry are comprehended to be 1 and above, therefore it has been determined that the air conditioning industry has competitiveness and specializes in exports. According to the product mapping method, it was revealed that the air conditioning industry has a comparative advantage however is in a net-importer (GROUP B). The noteworthy point in the study is that it was determined that the air conditioning sector was not affected much by the 2008 Global Economic Crisis, the 2018-21 Türkiye Foreign Exchange and Debt Crisis, and the Covid pandemic, therefore it is sight that the air conditioning sector maintains its competitiveness and continues to grow despite the crises. In the sector report of TOBB [52], a competitive analysis of the air conditioning sector was analyzed using the Diamond Model developed by Porter and it has been concluded that the Turkish air conditioning sector has a high level of competitiveness. Therefore, the results are parallel to the results of this study. As in the study of Lehtonen and Sipilä [19], it is emphasized that the air conditioning sector will alter in recent years, the sector will grow and the importance of the sector will gradually increase.

The results for the sub-products of the Turkish air conditioning industry can be summarized as follows:

The results of the heating sub-product group indicate that it specializes in the export of three products (HS Code 732181, HS Code 732211, and HS Code 840310), and that these products are in a net-exporter (GROUP A) with comparative advantage. However, it was revealed that there was no specialization in the export of the other three products in the heating sub-product group (HS Code 840220, HS Code 841610, and HS Code 851610) and that these products were net-importers (GROUP D) with a comparative disadvantage. In the other two products (HS Code 840410, HS Code 841939), it is realized that the competitiveness is at the limit.

The results of the refrigeration sub-product group display that it specializes in the export of two products (HS Code 841891, HS Code 841850), and that these products are in a net-exporter (GROUP A) with comparative advantage. However, in the other two products (HS Code 841990, HS Code 841989) it has been determined that our country does not indicate specialization in exports. According to the product mapping method, it has been revealed that it is a net-importer (GROUP D) with a comparative disadvantage.

The results of the air conditioning sub-product group demonstrate that Türkiye did not specialize in exports of two products (HS Code 841430, HS Code 841520) and that these products were net-importers (GROUP D) with a comparative disadvantage.

Results of the ventilation sub-product group reveal that Türkiye specializes in exports in two products (HS Code 830710, HS Code 841460), and these products are involved in of net-exporter (GROUP A) with comparative advantage.

As a result of the installation, it has been obtained that our country specializes in exports in three products (HS Code 391731, HS Code 392111, HS Code 741220) and that it is a net-exporter (GROUP A) with a comparative advantage in these products. However, in the other two products (HS Code 902511, HS Code 902610), it has been revealed that Türkiye does not specialize in exports and that these products are net-importer (GROUP D) with a comparative disadvantage.

The results of the insulation sub-product group indicates that Türkiye specializes in exports of only one product (HS Code 400819) and that this product is a net-exporter (GROUP A) with a comparative advantage. On the other hand, it has been revealed that our country does not specialize in exporting only one product (HS Code 680610) and that this product is a net-importer (GROUP D) with a comparative disadvantage. Another product (HS Code 701939) has limited competitive power. It is the only product in Group C in Türkiye's product mapping.

The companies in the air conditioning sector should improve a product portfolio with high quality, high benefit and unique design. Businesses operating in the air conditioning sector should support to establish an effective competitive intelligence system and training programs should organize for this purpose. R & D for the sector should be integrated into the production processes and encouraged in nowadays world where technological progress is at its peak. E-commerce networks should be improved to market the sector and its sub-products, and social media platforms should be utilized to increase the recognition of the sector. Universities, vocational high schools and companies within the scope of the air conditioning sector should cooperate and carry out activities in coordination. Foreign fair support should improve for companies in the sector. Qualified workforce support should provide and the opportunity to own a global brand should offer.

A new study can conduct to determine the competitiveness determinants of companies operating in the air conditioning sector, which has a high market share in international market. In addition, a qualitative study can carry out by interviewing company managers to determine what kind of strategy the companies that are strong in the air conditioning industry have developed to maintain their competitiveness. Finally, air conditioning industry global competitiveness of different countries can analyze and compare with other countries by revealing their comparative advantage over Türkiye.

This study has two limitations. First, the period could have gone back earlier. This study covers the years 2001-2021. Secondly, this study, which was created using secondary data, could have been enriched with field work. Qualitative research can be conducted with sector managers on what can be done to increase the exports of the air conditioning sector.

Acknowledgement

This study is derived from the master's thesis titled "Assessment of the air conditioning sector in Turkey within the context of foreign trade and international competitiveness".

Author contributions

Fatma İzgi: Conceptualization, Methodology, Software Writing-Original draft preparation
Mustafa Kavacık: Data curation, Validation, Visualization, Investigation, Writing-Reviewing and Editing.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Stigler, J. G. (1965). Essay in The History of Economics. The University of Chicago Press. Chicago.
2. Topallı, N., & Mercan, B. (2016). Rekabet Kavramına Yeni Bir Alternatif Yaklaşım: Sistemik Rekabet. International Conference on Eurasian Economies, 856-863.
3. Smith, A. (2002). An Inquiry into the Nature and Causes of the Wealth of Nations. Readings in Economic Sociology, 6-17.
4. Ricardo, D. (1817). On the Principles of Political Economy and Taxation, Library of Economics and Liberty https://www.econlib.org/library/Ricardo/ricP.html
5. Ohlin, B. G. (1933). Interregional and international trade. Cambridge, Harward University Press

6. Kenen, P. B. (1965). Nature, capital, and trade. Journal of Political Economy, 73(5), 437-460.
7. Keesing, D. B. (1966). Labor skills and comparative advantage. The American Economic Review, 56(1/2), 249-258.
8. Posner, M. V. (1961). International trade and technical change. Oxford Economic Papers, 13(3), 323-341.
9. Vernon, R. (1966). International investment and international trade in the product cycle. The Quarterly Journal of Economics, 80(2), 190–207. https://doi.org/10.2307/1880689
10. Krugman, P. (1979). A model of innovation, technology transfer, and the world distribution of income. Journal of Political Economy, 87(2), 253-266.
11. Grossman, E. M., & Helpman, E. (1989). Quality Ladders and product Cycles. NBER Working, 3201.
12. Lai, E. L. (1995). The product cycle and the world distribution of income A reformulation. Journal of International Economics, 39(3-4), 369-382.
13. Porter, M. E. (1990). The competitive advantage of nations. Harvard Business Review, 73-91.
14. Moon, H. C., Rugman, A. M., & Verbeke, A. (1998). A generalized double diamond approach to the global competitiveness of Korea and Singapore. International Business Review, 7(2), 135-150.
15. Cho, D. S. (1998). From national competitiveness to bloc and global competitiveness. Competitiveness Review: An International Business Journal, 8(1), 11-23.
16. Aiginger, K. (2006). Competitiveness: from a dangerous obsession to a welfare creating ability with positive externalities. Journal of Industry, Competition and Trade, 6, 161-177. https://doi.org/10.1007/s10842-006-9475-6
17. Cho, D. S., Moon, H. C., & Kim, M. Y. (2009). Does one size fit all? A dual double diamond approach to country-specific advantages. Asian Business & Management, 8, 83-102. https://doi.org/10.1057/abm.2008.27
18. ITC Trade Map (2022). Exporting and Importing Data of Air Conditioning. https://www.trademap.org/
19. Lehtonen, H., & Sipilä, L. (2007). Competitor analysis and strategic marketing planning in a HVAC company: Case company: LVI-Kallio Oy.
20. Srikandi, D., Sutopo, W., Hisjam, M., & Istiqomah, S. (2022). Commercializing a Technology Use Global Business Strategy Approach: A Lesson Learned from HVAC Companies. In Proceedings of the International Conference on Industrial Engineering and Operations Management, 3079-3090.
21. Isaac, M., & Van Vuuren, D. P. (2009). Modeling global residential sector energy demand for heating and air conditioning in the context of climate change. Energy Policy, 37(2), 507-521. https://doi.org/10.1016/j.enpol.2008.09.051
22. Visintin, F., & Rapaccini, M. (2010). Exploring the linkage between servitization and financial performances: evidences from the HVAC industry. In Proceedings of APMS 2010-International Conference on Advances in Production Management Systems, 1-8.
23. Acül, H. (2009). Türkiye İklimlendirme ve Tesisat Sektöründeki İşletmelerde Ar-Ge ve Yenilik Faaliyetlerinin Yönetimi Üzerine Öneriler. TMMOB Makine Mühendisleri odası, 25-49
24. Ors, H., & Yumus, F. (2018). İklimlendirme sektörünün rekabet gücünün belirleyicilerinin belirlenmesi. Press Academia Procedia, 7(1), 326-329. https://doi.org/10.17261/Pressacademia.2018.908
25. Erturan, A. (2019). İklimlendirme işletmelerinde finansal tablolar analizi ve bir uygulama. [Unpublished Master's Thesis, İstanbul Okan University].
26. Topçu, B. A., & Sarıgül, S. S. (2015). Comparative advantage and the product mapping of exporting sectors in Turkey. Akademik Sosyal Araştırmalar Dergisi, 3(18), 330-348.
27. Bashimov, G., & Aydın, A. (2018). Su ürünleri sektörünün rekabet gücünün analizi: Baltık Ülkeleri örneği. Türk Tarım ve Doğa Bilimleri Dergisi, 5(1), 48-55.
28. Bakkalcı, A. C. (2020). Türk otomotiv sektörünün RTA, RSCA, TBI endeksleri ile ürün haritalaması. Widodo'nun modeline farklı bir yaklaşım. The Journal of Social Sciences, 27(27), 108-126. https://doi.org/10.16990/SOBIDER.4436
29. Bakkalci, A. C. (2018). Küresel sistemde Türk tekstil sektörünün ürün haritalaması yöntemiyle analizi. Yönetim ve Ekonomi Dergisi, 25(3), 569-585. https://doi.org/10.18657/yonveek.410347
30. Kesgingöz, H. (2018). The analysis of Turkish agricultural sector by comparative advantage method. Business & Management Studies: An International Journal, 6(2), 508-523. https://doi.org/10.15295/bmij.v6i2.267
31. Yeldan, M., Kesgingöz, H., & Güçlü, U. (2020). Analysis of Turkey's iron-steel industry in the world trade. Uluslararası Yönetim İktisat ve İşletme Dergisi, 16(4), 854-869. https://doi.org/10.17130/ijmeb.811175
32. Başkol, M. O., & Bektaş, S. (2021). Türkiye demir-çelik sektörünün ürün haritalaması: widodo yöntemiyle bir analiz. Yönetim Bilimleri Dergisi, 19, 57-84. https://doi.org/10.35408/comuybd.973529
33. Ishchukova, N., & Smutka, L. (2013). Comparative advantage: products mapping of the Russian agricultural exports. Agris on-line Papers in Economics and Informatics, 5(3), 13-24. https://doi.org/10.22004/ag.econ.157521
34. Khaksar, A. H., Yaghoubi, M., & Kalateharabi, V. (2014). Determining revealed comparative advantage and target markets for Iran's stone fruits. Journal of Agricultural Science and Technology, 16(2), 253-264.
35. Ishchukova, N., & Smutka, L. (2014). " Revealed" comparative advantage: products mapping of the Russian agricultural exports in relation to individual regions. Acta Scientiarum Polonorum. Oeconomia, 13(1), 45-61.
36. Pawlak, K. (2018). Comparative advantages of the Polish agri-food sector on the US market. In Proceedings of the International Scientific

Conference. Economic Sciences for Agribusiness and Rural Economy. 2, 223-230. https://doi.org/10.22630/ESARE.2018.2.29
37. Saeyang, R., & Nissapa, A. (2021). Trade competitiveness in the global market: an analysis of four palm oil products from Indonesia, Malaysia and Thailand. International Journal of Agricultural Technology, 17(3), 1077-1094
38. Tandra, H., Suroso, A. I., Syaukat, Y., & Najib, M. (2022). The determinants of competitiveness in global palm oil trade. Economies, 10(6), 132. https://doi.org/10.3390/economies10060132
39. Saxena, R., Kumar, A., Singh, R., Paul, R. K., Raman, M. S., Kumar, R., ... & Agarwal, P. (2022). Examining export advantages in Indian horticulture: an approach based on product mapping and seasonality. Journal of Agribusiness in Developing and Emerging Economies, 14(2), 161-192. https://doi.org/10.1108/JADEE-12-2021-0310
40. Balassa Indexes (2003). Balassa Indexes. 155-156.
41. Balassa, B. (1965). Trade liberalisation and "revealed" comparative advantage. The Manchester School, 33(2), 99-123. https://doi.org/10.1111/j.1467-9957.1965.tb00050.x
42. Vollrath, T. L. (1991). A theoretical evaluation of alternative trade intensity measures of revealed comparative advantage. Weltwirtschaftliches Archiv, 127(2), 265-280. https://doi.org/10.1007/BF02707986
43. Lederman, D., Olarreaga, M., & Rubiano, E. (2008). Trade specialization in Latin America: the impact of China and India. Review of World Economics, 144, 248-271. https://doi.org/10.1007/s10290-008-0146-z
44. Frohberg, K., & Hartmann, M. (1997). Comparing measures of competitiveness. Institute of Agricultural Development in Central and Eastern Europe.
45. Sarıçoban, K., & Kösekahyaoğlu, L. (2019). Ticaret sonrası verilerle rekabet gücünün ölçülmesinde kullanılan indeksler üzerine bir literatür taraması. The Journal of Academic Social Science, 47(47), 424-444.
46. Gürpınar, K., & Barca, M. (2007). Türk mobilya sektörünün uluslararası rekabet gücü düzeyi ve nedenleri. Eskişehir Osmangazi Üniversitesi İİBF Dergisi, 2(2), 41-61.
47. Laursen, K. (2015). Revealed comparative advantage and the alternatives as measures of international specialization. Eurasian Business Review, 5, 99-115. https://doi.org/10.1007/s40821-015-0017-1
48. Dalum, B., Laursen, K., & Villumsen, G. (1998). Structural change in OECD export specialisation patterns: de-specialisation and 'stickiness'. International Review of Applied Economics, 12(3), 423-443. https://doi.org/10.1080/02692179800000017
49. Lafay, G. (1992). The measurement of revealed comparative advantages. In International Trade Modelling, 209-234. Springer US.
50. Widodo, T. (2009). Comparative advantage: theory, empirical measures and case studies. Review of Economic and Business Studies (REBS), (4), 57-82.
51. HVAC-R Exporters Association (ISIB) (2023). Export Data of January- December-2022. https://isib.org.tr/aylik-ihracat-verileri/
52. TOBB, Türkiye Odalar ve Borsalar Birliği (2012). Türkiye İklimlendirme Sanayi Sektör Raporu 2012. https://www.tobb.org.tr/documents/yayinlar/2012/Tobb