RESEARCH ARTICLE

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Export competitiveness of Türkiye's agricultural machinery and equipment sector

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Abstract
The aim of the study is to determine the competitiveness of Turkey's agricultural machinery and equipment sector. Balassa's Revealed Comparative Advantage (RCA) approach was used in the period 2002-2021 by using International Trade Center database. Balassa's Revealed Comparative Advantage RCA2 Index for 39 agricultural machinery and equipment product groups (their sub-product groups of 69, 82, 84, 87) related to Harmonized System 6-digit product classification, Vollrath's Relative Export Advantage-RXA, Net Export Index-NEI, and Export-Import Rate Index-EIRI indices were calculated. According to the results, while Turkey has a competitive advantage in 13 of the agricultural machinery and equipment product group exports, it has a competitive disadvantage in the other 26 product groups.
Keywords: Agricultural Machinery and Equipment, Revealed Comparative Advantages, Vollrath Index, Net Export Index, Export-Import Rate Index

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INTRODUCTION

The advantages of free trade and international specialization are demonstrated by Ricardo's theory of comparative advantage. Analyzing a country's foreign trade structure is required to ascertain its comparative advantage on a product or sectoral basis (Kilicarslan, 2019). Developing countries like Turkey have changed the dynamics of the global economy (Aktas Cimen & Kutlu, 2023; Reddy, 2018). According to the International Monetary Fund (2020), despite the expectation of a slowdown in global trade in 2023; expectations for emerging economies are stronger than for developed economies. A good, strong, and innovative one in the global economy has a competitive advantage (Saricoban & Yalcin, 2020).

Competitiveness in the global environment is defined as the ability of an industry (firm, country) to trade in the global market in a sustainable manner (Fronberg & Hartmann, 1997; Esterhuizen & Van Rooyen, 2001). This study focuses on the analysis of Turkey's agricultural machinery and equipment sector. It evaluates Turkey's competitiveness in global markets in the relevant sector in terms of the position of exported products and reveals the competitiveness of the sector. It is of great importance in terms of planning targets and forming government policies in order to increase the competitiveness of the sector (Startiene & Remeikiene, 2014). It is also useful for seeing the results of policy changes and assessing its contribution to economic well-being. In order to analyze the sectoral changes that may occur due to various factors, it would be more accurate to evaluate the past years with a holistic approach (Akyuz et al., 2020).

The first index to measure competitiveness using post-trade data was introduced by Liesner (1958) and Balassa (1965) developed this index. Later, Vollrath (1991)

said that Balassa did not include enough imports and made a double counting error, and he developed Balassa's index and revealed the Vollrath Index.

In this study the competitiveness of Turkey's exports of agricultural machinery and equipment will be determined using the Revealed Comparative Advantage (RCA) approach. In order to achieve this, RCA coefficients were generated for each product group using the International Trade Center (ITC) Trade Map, annual time series, export and import data (x1000 USD), and 6-digit product classification. In the analysis, 39 different product groups in the 6-digit classification within the 69, 82, 84, 87 product codes were interpreted separately.

Overview of Agricultural Machinery and Equipment Exports

Turkey and the world's exports of agricultural machinery and equipment between 2002-2021 and their share in total exports were shown in Table 1. Table shows that Turkey's exports of agricultural machinery and equipment have been in an increasing trend in the 20-year period examined, excluding the 2009 financial crisis. Turkey's agricultural machinery and equipment exports, which emerged in December 2019 and had a global impact in a short time, decreased by 8.69% in 2020, but decreased by 2.66% in 2021. Agricultural machinery and equipment, which had a share of 0.29% in Turkey's exports in 2002, increased to 0.48% in 2009, 0.75% in 2020, 0.73% in 2021. The share of world agricultural machinery and equipment exports in the World exports shows a partially stable outlook. Agricultural machinery and equipment exports, which had a share of 0.40% of the world's exports in 2002, share declined to 0.37% in 2006. However, although the share of agricultural machinery and equipment exports in world exports increased to 0.44% in 2008, it declined to 0.41% in 2009 due to the financial crisis.

World exports of agricultural implements and equipment, whose share in world exports fluctuated slightly between 2010 and 2021, accounted for 0.41% of exports in 2021. Although it increased by 7.69% in 2020 after the Covid-19 pandemic, it decreased by 2.38% in 2021. So, the epidemic seems to have affected Turkey's agricultural machinery and equipment exports more than the World's agricultural machinery and equipment exports. The increase in the share of agricultural machinery and equipment exports in total exports both in Turkey and in the world in 2020 may be due to the decrease in total exports due to the prohibitions and restrictions introduced to prevent the Covid-19 epidemic. However, while the share of agricultural machinery and equipment exports in the world's total exports in the 2002-2021 period examined, the share of agricultural machinery and equipment exports in Turkey's total exports is increasing.

Table 1. General Outlook of Exports of Agricultural Machinery and Equipment in Turkey and the World (2002-2021)

Year	Total Export of Turkey (1000 US $)	Total Agricultural Machinery and Equipment Exports of Turkey (1000 US $)	Rate (%)	Total Export of World (1000 US $)	Total Agricultural Machinery and Equipment Exports of World (1000 US $)	Rate (%)
2002	35761981	103085	0.29	6432105964	25693391	0.40
2003	47252836	228288	0.48	7498530918	29587322	0.39
2004	63120949	262052	0.42	9110737596	36383071	0.40
2005	73476408	283701	0.39	10360495753	40514027	0.39
2006	85534676	317204	0.37	11979108568	44807336	0.37
2007	107271750	414278	0.39	13809800618	54540516	0.39
2008	132027196	564629	0.43	16007659828	70206795	0.44
2009	102142613	485673	0.48	12384813282	50780145	0.41
2010	113883219	532938	0.47	15098981170	54769620	0.36
2011	134906869	626603	0.46	18141372916	70406035	0.39
2012	152461737	806325	0.53	18399990900	72907729	0.40
2013	161480915	853309	0.53	18858726557	74700191	0.40
2014	166504862	1022732	0.61	18862399126	73441172	0.39
2015	143844066	945804	0.66	16416895796	63892286	0.39
2016	142606247	860669	0.60	15923096945	62107793	0.39
2017	156992940	951580	0.61	17561440015	70440948	0.40
2018	167923862	1127056	0.67	19327897410	75898338	0.39
2019	180870841	1243226	0.69	18750885146	73187422	0.39
2020	169657940	1264995	0.75	17488466269	73160595	0.42
2021	225264314	1646014	0.73	22112533133	90904116	0.41

Source: Prepared by using Trade Map data (Trade Map, 2023).

Literature Review

In the literature research, only one scientific study was found regarding the competitiveness of Turkey's agricultural machinery and equipment sector. Berk & Erdem (2019) compared the agricultural machinery and tractor exports of Turkey with some selected countries with RCA, RXA, and Relative Trade Advantage (RTA) and Revead Competitiveness (RC) indices between 2008 to 2017. According to the results, the Turkish agricultural machinery and tractor sector is highly sensitive to local currency and inflation rates. RCA index was a minimum 0.68 in 2008 and a maximum of 1.15 in 2015.

While Kosekahyaoglu & Ozdamar (2005) comparatively analyzed Turkey and Czech Republic, Hungary, Poland, and Estonia, which are members of the European Union, in terms of sectoral competitiveness and foreign trade structures, the different forms of RCA, NEI, lnRCA2,3 and Donges Comparative Export Performance (CEP) indices. Altay & Gurpinar (2008) used RCA, RXA, NEI, The Relative Import Advantage (RMA) , RTA, RC, Export Smiliraty Index (ESI) to determine the international competitiveness of the Turkish furniture industry. Sarica (2016) examined the competitiveness of Turkey's foreign trade in agricultural products with the help of RCA, RC, RTA and Revelaed Export Advantage Index (lnRXA). Erkan (2013), RCA2, RXA2, and EIRI to examine the competitiveness of Turkey's textile and apparel industry exports between 1993 and 2009. Erkan & Batbayli (2017) revealed the global markets in terms of exports on a sectoral basis for the Black Sea Economic Cooperation Organization (BSEC-12) countries and Turkey with the "export similarity index"; Balassa's RCA and Vollrath's RXA Indexes to measure the competitiveness of 12 BSEC members in the period of 2000-2014. Saricoban & Kosekahyaoglu (2017b) used RCA and RXA2 indices to measure Turkey's export competitiveness in agricultural product groups. Cestepe & Tuncel (2018) used RTA, RC and Vollrath index to determine the international competitiveness of the Turkish iron and steel industry for the period of 2007-2016. Magezi & Okan (2019) investigated the competitiveness of Turkey and EU countries in forest products trade for the period of 2006-2016 by using the RCA, RXA, RMA, RTA, Cross Relative Export Advantage, Cross Relative Import Advantage CRMA, and Logarithmic Cross Relative Competitiveness indexes. Akyuz et al. (2020) used the RCA, RXA, RMA, RTA, lnRXA, and RC indexes to determine the competitive position of the Turkish forest products industry for the period of 2001-2017. Saricoban & Yalcin (2020) used RCA2, RXA, and NEI indices to determine the export competitiveness of Turkey's carpet industry by RCA index. Ozbas & Yildirim (2022) used the RCA, RXA, and RTA indexes to determine the top ten products in which Turkey has the highest competitive power for the period of 2001-2019. Ortikov et al. (2019) determined Uzbek foreign trade in agriculture with different groups of countries. Agrarian trade competitiveness and territorial and commodity structure changes were analyzed between 2000 and 2018 by using "product mapping approach" method, Herfindahl-Hirschman Index, Lafay Index LI, and NEI. According to the results, Uzbek agricultural exports are competitive with regard to Asian and CIS countries, and limited when compared with other territories. Erdem (2020) searched the competitiveness of the world dried product sector such as apples, prunes, apricots, figs, and grapes. In this study, the data was subjected to the RCA, RXA, RMA, RTA and RC indexes for 2007 to 2017 data of China, USA, Chile, Germany, Iran, the Netherlands, South Africa, France, Uzbekistan, Argentina, Spain, Turkey, and India. Results showed that the world dried product sector is very responsive to economic crises and to local currency rate. The RCA index was found to be 4.66 in 2007 for Turkey and it decreased to 4.45 by 2009 during the World economic crisis. The other breaking point was 2013 when Turkey experienced both economic and political crises. Saptana et al. (2021) determined the competitiveness of shallot in Indonesia. The results showed that shallot farming in Indonesia has both competitive and comparative advantages. While the highest competitive and comparative advantages were found in the dry season in the upland of Malang district with the coefficient values of PCR (Private Cost Ratio) of 0.268-0.508 and DRCR (Domestic Resource Cost Ratio) of 0.208–0.323, the lowest competitive advantage was found in the lowland of East Lombok district in the dry season with a coefficient value of PCR 0.728–0.844. So, it is more profitable for Indonesia to increase domestic shallot production than to import. Improving shallot competitiveness can be carried out by implementing advanced technology, agricultural infrastructure, capacity building of farmers' resources, and government incentive policies to increase productivity and competitiveness sustainability. Torayeh (2013) analyzed the export competitiveness of Egypt's agricultural exports in the European Union between 1998 and 2010 by RCA index and CEP index. Results showed that although Egypt's exports of fruit & vegetables to the EU are growing, it is limited to the competition from other MEDC which has grown dramatically in the last years. The results revealed that while Egypt is losing its comparative advantages in Saudi market, Russian and Ukrainian markets are found to be more optimistic. Egypt experienced a progressive trend in gaining a comparative advantage in exporting agricultural products in comparison to the main rivals. Zhang and Sun (2022), examined the static distribution of agricultural trade comparative advantage in countries along the Belt and Road (B&R) and China by utilizing the Balassa RCA index, Revealed Symmetric Comparative Advantage index and the ordinary least squares correlation analysis. The results showed that the initial comparative advantage of most agricultural products along the B&R and China deteriorated, simultaneously, but the initial comparative disadvantage of most and

some agricultural products along the B&R and China improved, respectively. Pakravan and Kalashami (2011) searched Iran, U.S, and Turkey's pistachio export by RCA using agricultural and total economy export, then forecasted by using Auto-Regressive Integrated Moving Average approached for 2008-2013. The results showed that, Turkey and Iran had comparative advantage in pistachio export in 1982-2007, but US did not. Also, forecasting RCA index, based on both commodity baskets, show the improvement of US Pistachio export situation, unlike the values of RCA index forecasting for Iran and Turkey is falling. Long (2021) analyzed the international competitiveness of six China's representative agricultural products by TC and RCA index between 1994 and 2013. The results indicated that, China should vigorously promote the production and foreign trade in traditional agricultural products. At the same time, comprehensive measures should be taken to enhance the international competitiveness of disadvantaged agricultural products.

METHOD

In the study, the RCA method was used. RCA coefficients compare the domestic specialization of a country in a sector with the specialization of the world or any country (Erkan, 2013).

In the analysis of the study, Balassa's Comparative Advantage (RCA2) method, which is frequently used in the literature to measure competitiveness with post-trade data, was later developed by Vollrath in 1991, the RXA, NEI and EIRI were used.

Balassa's RCA_2

The first index to measure competitiveness using export data is the Liesner Index (L-RCA), which was introduced by Liesner in 1958. Balassa (1965) developed the RCA1-Revealed Comparative Advantage Index by making the L-RCA index more functional (Saricoban & Kosekahyaoglu, 2017a). Balassa changed the RCA Index in 1977, 1979 and 1986 (Jagdambe, 2019). Balassa's RCA2 Index compares a country's share in total exports of a product or industry with its share in the world (or group of countries) total exports of the product or industry under consideration (Esterhuizen & Van Rooyen, 2001; Mykhnenko, 2005). In other words, it is used to calculate the relative advantage or disadvantage of a country in a product or sector (Startiene and Remeikiene, 2014). Balassa's RCA_2 Index is formulated as follows (Balassa, 1965);

$$RCA_2 = \frac{X^j_{kt}/X^j_t}{X^w_{kt}/X^w_t} \qquad (1)$$

Where;

X^j_{kt} Export of 'k' good (or sector) in 't' period of country 'j',

X^j_t Total exports of country 'j' in period 't',

X^w_{kt} Total world exports of good (or sector) 'k' in period 't',

X^w_t World total export values in the 't' period. The results of this index are interpreted as follows (Saricoban et al., 2017; Sarıçoban & Kösekahyaoğlu, 2017_b);

- If RCA2>1, country 'j' export share of 'k' good (or sector) is greater than the world's share of 'k' (sector) export. This indicates that country j has competitive power in the export of 'k' good (sector).

- If RCA2<1, the export share of 'k' good (or sector) of country 'j' is smaller than the export share of 'k' good (sector) of the world. This indicates that country j has a competitive disadvantage in the export of 'k' good (sector).

- If RCA2=1, the export share of 'k' good (sector) of country 'j' is equal to the world's share of export of 'k' good (sector). This indicates that there is a balance in the export competitiveness of goods 'k' (sector).

In summary, if RCA2>1, then that country has a comparative advantage in the product (or industry) and is relatively more specialized in terms of exports (Bojnec & Ferto, 2006).

Hinloopen and Van Marrewijk (2001) made a fourfold classification as follows in order to make the RCA Index results easier to interpret. This classification is detailed;

Class 1, 0<RCA≤1, No advantage, no competitiveness,

Class 2, 1<RCA≤ 2, Weak competitiveness,

Class 3, 2<RCA≤ 4, Medium advantage,

Class 4, 4<RCA, Strong competitiveness. Class 1 relates to sectors that do not have a comparative advantage, while class 2-3-4 relates to roughly all sectors with comparative advantage.

Vollrath's RXA

Vollrath's RXA Index is based on the RCA Index developed by Balassa (1965). Unlike Balassa's RCA Index, the RXA Index prevents double couting and increases the reliability of the results (Saricoban & Yalcin, 2020). The RXA Index is defined as the relationship between the rate of exports of some products of a country in the world market and the rate of exports of all other products of this country in the world market (Hambalkova, 2006). The index results provide the opportunity to compare the domestic specialization of a country in a certain sector (or product group) with the world specialization. Vollrath's RXA Index is calculated using the following equation (Fronberg & Hartmann, 1997; Saricoban & Kosekahyaoglu, 2017a; Saricoban & Yalçın, 2020):

$$RXA = \frac{X^{j}_{kt}/X^{j}_{-kt}}{X^{-j}_{kt}/X^{-j}_{-kt}} \quad (2)$$

Where;

X^{j}_{kt} Export of 'k' good (or sector) in 't' period of country 'j',

X^{j}_{-kt} Total exports of country 'j' excluding commodity 'k' in period 't',

X^{-j}_{kt} Total world exports of 'k' good (or sector) excluding '' in the 't' period,

X^{-j}_{-kt} World total exports excluding X^{-j}_{kt} and X^{-j}_{-kt} in the 't' period.

Index results are interpreted as follows (Hambalkova, 2006; Saricoban & Yalcin, 2020);

- RXA>1, the country has a comparative advantage (competitive advantage) in the evaluated product category,

- If RXA<1, it indicates that the country has a comparative disadvantage (competitive disadvantage).

RXA Index results can be divided into 4 groups and interpreted in more detail (Hinloopen and Van Marrewijk, 2001);

Class 1: 0<RXA≤1, No advantage, no competitiveness (specialization),

Class 2: 1<RXA≤2, There is poor competitiveness (weak specialization),

Class 3: 2<RXA≤4, Moderate advantage/competitiveness (medium specialization),

Class 4: 4<RXA means strong competitiveness (strong convergence).

NEI

According to Gnidchenko and Salnikov (2015), an appropriate comparative advantage index should reflect net trade. The RCA Index is calculated only with export values and does not take into account import data. NEI, also an RCA method, is interpreted as a country's relative ability to profit from trade in a particular product (Gnidchenko & Salnikov, 2021). The index describes an assessment of a country's trade with the rest of the world. NEI, which is calculated by dividing the export and import difference of a particular product group by the sum of exports and imports, takes values between "-1" and "+1" (Balassa & Noland, 1989). NEI is formulated as follows (Saricoban & Kosekahyaoglu, 2017a; Saricoban & Yalcin, 2020.);

$$NEI^{j}_{kt} = -\frac{X^{j}_{kt} - M^{j}_{kt}}{X^{j}_{kt} + M^{j}_{kt}} \quad (3)$$

Where;

Xjkt Export of 'k' good (or sector) in 't' period of country 'j'

Mjk Import of 'k' good (or sector) in 't' period of country 'j'.

NEI^{j}_{kt} =-1; Negative values indicate full imports in that product group (or sector). Import is more important and the country has a competitive disadvantage in that product group (or sector),

NEI^{j}_{kt} =1; Positive values indicate full exports in that product group (or sector). Export is more significant and demonstrates the nation's advantage in that product group (or sector),

NEI^{j}_{kt} =0; It expresses a balanced situation in trade and the existence of maximum intra-industry trade.

NEI value of '-1' or '+1' indicates that there is no intra-industry trade (Bozduman & Erkan, 2019).

EIRI

The fact that only export-related data is used in the measurement of competitiveness is criticized in some studies. Bowen (1983) states that it would be a more accurate approach to measure competitiveness with a method based on net exports (export-import), which includes not only exports but also imports. The index provides information about the level of specialization in the goods exported by a country and is formulated as follows (Mikic, 2005; Erkan, 2013; Saricoban & Kosekahyaoglu, 2017a);

$$RCA_{4} = \frac{X^{j}_{kt}/X^{j}_{t}}{M^{j}_{kt}/M^{j}_{t}} \quad (4)$$

Where,

X^{j}_{kt} Country 'j' exports of good (or sector) 'k' in period 't',

X^{j}_{t} Total exports of country 'j' in period 't',

M^{j}_{k} Country 'j' imports of good (or sector) 'k' in period 't',

M^{j}_{t} Total imports of country 'j' in period 't'.

If;

-RCA4>1, if country 'j' specializes in commodity 'k' (or sector) and has a comparative advantage (competitive advantage) in the export of this commodity;

-RCA4<1 indicates that country 'j' is disadvantaged in commodity (or sector) 'k', that is, its export performance is low (Mikic, 2005).

RESULTS AND DISCUSSION

In the analyzes, the RCA coefficients in Turkey's agricultural machinery and equipment sector exports were calculated based on the "Trimmed Mean (TM)" values. TM, eliminating the highest and lowest values in a series and taking the arithmetic mean of the remaining values (Statistics, 2023). At the next stage, the distribution characteristic of the average RCA values of the sectors (volatility around the period average) was determined by means of the Coefficient of Variance (CV) (Kucukkiremitci, 2006). That is, the higher the CV, the higher the deviation from the mean. A product with a comparative advantage has a low CV value, indicating that its competition is stable. Erkan & Batbaylı (2017) stated that if the CV value is below 15 in the RCA and RXA indexes used by the BSEC member countries to determine their comparative advantage in global markets, it indicates that the competition of the product groups is stable.

A total of 49 product groups were selected for analysis, and 39 product groups formed as a result of combining some product groups are presented in Table 2. Abbreviations used in tables;

-Product Code: PC

-2002-2011 Average: A (arithmetic average of 10 years RCA coefficients)

-2012-2021 Average: B (arithmetic average of 10 years RCA coefficients)

-The Superiority Rating expresses the status of superiorities relative to the appropriate average RCA values.

Balassa's RCA Results

RCA coefficient values for Turkey's agricultural tools and equipment product group are presented in Table 3.

According to the Table, the TM values show that 13 out of 39 product groups have a competitive advantage and 26 have a competitive disadvantage. Turkey has a strong competitive advantage in 4 out of 13 product groups, a moderate advantage in 3 and a weak advantage in 6. The product group coded '843780' has the highest competitive advantage, the product group coded '843410' has the highest moderate advantage and the product group coded '843610' has the highest weak advantage.

Among the 26 product groups in which Turkey is disadvantaged, the arithmetic average of RCA values decreased in the second period compared to the first period of only 6 product groups did change. However, the increase in the arithmetic mean of RCA values in the second period compared to the first period of 20 product groups, which are disadvantaged in competition, is remarkable and the changes that should be especially emphasized. The arithmetic mean of the RCA values of the product groups '870110', '820190', '843319', '820160' and '843311' decreased in the second period. The most disadvantageous is the product group with the code '843311'.

Vollrath's RXA Results

The results according to TM values are presented in Table 4.

According to the table, Turkey has a competitive advantage in 13 product groups and a competitive disadvantage in 26 product groups in 39 agricultural tools and equipment exports. Among the product groups in which Turkey has an advantage, 4 have a strong advantage, 3 have a moderate advantage and 6 have a weak advantage. The increases in the RCA values of the products coded '843780' and '843790', which are in the first two ranks where Turkey has a strong advantage, in the second period indicate an increase in their competitiveness. However, the decline in the RCA value of the product group coded '843352', which ranks third, in the second period indicates a loss of competitiveness. The increase in the competitiveness of the other 3 product groups in the second period, except for the product group coded 843352 in the strong superiority group, is promising for Turkey and the sector. This result indicates that the policies implemented were successful. The CV value of the first 2 products with strong competitive advantage varies between '26.79' and '28.49' and is partially lower than the other product groups. This finding indicates that exports of the first 2 product groups with strong competitive advantage are more stable, albeit partially.

According to TM values, 2 of the 3 product groups coded '843410', '843210', '843629', which are ranked as moderately superior, reached strong superiority in the second period, except for the product group coded '843410'. These changes should be particularly emphasized. The product group coded "843210' has the lowest CV value of '32.11' and seems to be more stable in competition.

26 product groups are disadvantaged according to TM values. However, 20 disadvantaged product groups have reached an advantageous position in the second period compared to the first period. In addition, the fact that the product groups coded '843240', '841939', '843290', '871620' and '842490' had no competitiveness in the first period, but increased to weak superiority in the second period indicates increases in competitiveness. However, the decline in the RCA value of the product group coded '870110', '820190', '820150', '843319', '820160' and ' 843311' in the second period indicates a decrease in competitiveness. Products in the weak superiority classification are on the advantage/disadvantage border

Table 2. List of Product Codes and Labels of Agricultural Machinery and Equipment Products

	Product code	Product label
1	690990	Ceramic troughs, tubs and similar receptacles of a kind used in agriculture; ceramic pots, jars and similar articles of a kind used for the conveyance or packing of goods (excluding general-purpose storage vessels for laboratories, containers for shops and household articles)
2	820150	Secateurs and similar one-handed pruners and shears, incl. poultry shears, with working parts ...
3	820160	Hedge shears, two-handed pruning shears and similar two-handed shears, with working parts of base metal
4	820190	Scythes, sickles, hay knives, timber wedges and other hand tools of a kind used in agriculture, horticulture or forestry, with working parts of base metal (excluding spades, shovels, mattocks, picks, hoes, rakes, axes, billhooks and similar hewing tools, poultry shears, secateurs and similar one-handed pruners and shears, hedge shears, two-handed pruning shears and similar two-handed shears)
5	820840	Knives and cutting blades, of base metal, for agricultural, horticultural or forestry machines (excluding those for wood-working)
6	842490*	Parts of fire extinguishers, spray guns and similar appliances, steam or sand blasting machines
7	843210	Ploughs for use in agriculture, horticulture or forestry
8	843221	Disc harrows for use in agriculture, horticulture or forestry
9	843229	Harrows, scarifiers, cultivators, weeders and hoes for use in agriculture, horticulture or ...
10	843230**	Seeders, planters and transplanters for use in agriculture, horticulture and forestry
11	843240***	Manure spreaders and fertiliser distributors for use in agriculture, horticulture and forestry
12	843280	Agricultural, horticultural or forestry machinery for soil preparation or cultivation; lawn ...
13	843290	Parts of agricultural, horticultural or forestry machinery for soil preparation or cultivation ...
14	843311	Mowers for lawns, parks or sports grounds, powered, with the cutting device rotating in a horizontal ...
15	843319	Mowers for lawns, parks or sports grounds, powered, with the cutting device rotating in a vertical ...
16	843320	Mowers, incl. cutter bars for tractor mounting (excluding mowers for lawns, parks or sports ...
17	843330	Haymaking machinery (excluding mowers)
18	843340	Straw or fodder balers, incl. pick-up balers
19	843351	Combine harvester-threshers
20	843352	Threshing machinery (excluding combine harvester-threshers)
21	843353	Root or tuber harvesting machines
22	843359	Harvesting machinery for agricultural produce (excluding mowers, haymaking machinery, straw ...
23	843360	Machines for cleaning, sorting or grading eggs, fruit or other agricultural produce (excluding machines for cleaning, sorting or grading seed, grain or dried leguminous vegetables of heading 8437)
24	843390	Parts of harvesting machinery, threshing machinery, mowers and machines for cleaning, sorting ...
25	843490	Parts of milking machines and dairy machinery, n.e.s.
26	843410	Milking machines
27	843610	Machinery for preparing animal feedingstuffs in agricultural holdings and similar undertakings (excluding machinery for the feedingstuff industry, forage harvesters and autoclaves for cooking fodder)
28	843621	Poultry incubators and brooders
29	843629	Poultry-keeping machinery (excluding machines for sorting or grading eggs, poultry pickers of heading 8438 and incubators and brooders)
30	843680	Agricultural, horticultural, forestry or bee-keeping machinery, n.e.s.
31	843691	Parts of poultry-keeping machinery or poultry incubators and brooders, n.e.s.

32	843699	Parts of agricultural, horticultural, forestry or bee-keeping machinery, n.e.s.
33	841939	Dryers (excl. lyophilisation 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)
34	843710	Machines for cleaning, sorting or grading seed, grain or dried leguminous vegetables
35	843780	Machinery used in the milling industry or for the working of cereals or dried leguminous vegetables (excluding farm-type machinery, heat treatment equipment, centrifugal dryers, air filters and machines for cleaning, sorting or grading seed, grain or dried leguminous vegetables)
36	843790	Parts of machinery used in the milling industry or for the working of cereals or dried leguminous vegetables or machines for cleaning, sorting or grading seed, grain or dried leguminous vegetables, n.e.s.
37	870110	Pedestrian-controlled agricultural tractors and similar tractors for industry (excluding tractor units for articulated lorries)
38	870190****	Tractors (excluding those of heading 8709, pedestrian-controlled tractors, road tractors for semi-trailers and track-laying tractors)
39	871620	Self-loading or self-unloading trailers and semi-trailers for agricultural purposes

Source: Prepared by using Trade Map data (Trade Map, 2023).
*As of 2017, product code 842490 also includes data for 842482 Agricultural or horticultural mechanical appliances, whether or not hand-operated, for projecting. For analysis, this product code was collected by us since 2017 and analyzed with the product code 842490 as before 2017.
**As of 2017, product code 843230 also includes product codes 843231 No-till direct seeders, planters and transplanters and 843239 Seeders, planters and transplanters (excl. no-till machines).
***Since 2017, product code 843240 also includes product codes 843241 Manure spreaders (excl. sprayers) and 843242 Fertiliser distributors (excl. sprayers and manure spreaders).
****From 2017, product code 870190, 870191 Tractors, of an engine power <= 18 kW (excl. those of heading 8709, pedestrian controlled tractors, road tractors for semi-trailers and track-laying tractors), 870192 Tractors, of an engine power > 18 kW but <= 37 kW (excl. those of heading 8709, pedestrian-controlled tractors, road tractors for semi-trailers and track-laying tractors), 870193 Tractors, of an engine power > 37 kW but <= 75 kW (excl. those of heading 8709, pedestrian-controlled tractors, road tractors for semi-trailers and track-laying tractors), 870194 Tractors, of an engine power > 75 kW but <= 130 kW (excl. those of heading 8709, pedestrian controlled tractors, road tractors for semi-trailers and track-laying tractors) and 870195 Tractors, of an engine power > 130 kW (excl. those of heading 8709, pedestrian-controlled tractors, road tractors for semi-trailers and track-laying tractors).
Note: The product codes were determined by the researchers with reference to the codes of the Republic of Turkey Ministry of Commerce, GTIP NO: 842441-842449-842482-8432-8433-8436-8478-870110-870191-870192-870193-870194-870195-871620 (Ticaret Bakanlığı (TB), 2023) was selected.

in terms of RCA coefficients. Therefore, they are priority product groups that should be taken into consideration in order not to lose competitive advantage.

NEI Results

The results of the analysis of Turkey's competitiveness and especially the level of specialization in Turkey's foreign trade in agricultural machinery and equipment with NEI are given in Table 5.

According to the table, Turkey has specialized in exports of 23 product groups and has a competitive advantage. However, Turkey has not been able to specialize in the exports of 16 product groups and has no competitive advantage. The 3 product groups with the highest level of specialization in Turkey's agricultural machinery and equipment exports are coded '843210', '843221', '843780' respectively. The competitiveness of the product groups coded '843352' and '843330', which are in the competitive advantage group, declined in the second period. In the product groups coded '843691', '843710', '843390', '843680', '843490', imports were more important in the first period and had a competitive disadvantage, while exports were more important in the second period and they reached a competitive position. This result indicates that the competitiveness of the sector has increased. Another positive development is that Turkey's imports decreased in 12 of the 16 product groups in which Turkey is a full importer. However, there is an increase in the imports of product groups coded '820160', '843359', '843353', '870110'. It should be emphasized that most of the product groups of the agricultural machinery and equipment sector increased their level of specialization in the second period and had a competitive advantage.

EIRI Results

The results of the analysis with the EIRI, which measures Turkey's intra-industry trade and is used only to determine Turkey's own trade performance, are presented in Table 6.

According to the table, Turkey has a competitive advantage in the exports of 24 product groups in the agricultural machinery and equipment sector. In other words, its trade performance is high. However, it has a disadvantage in the exports of 15 product groups and its export performance is low. The 3 product groups with the highest trade performance in Turkey's agricultural

Table 3. Balassa Index and Turkey's Agricultural Machinery and Equipment Product Group RCA Coefficients and Superiority Degrees

	PC	A	B	TM
Strong Superiority	843780	14.97	21.59	18.34
	843790	5.02	5.23	5.04
	843352	6.59	3.50	4.90
	843710	4.04	4.77	4.29
Moderate Superiority	843410	4.01	3.84	3.84
	843210	2.59	3.32	2.92
	843629	1.55	3.42	2.48
Weak Superiority	843610	1.11	2.95	1.97
	870190	1.52	2.21	1.87
	843230	1.06	2.34	1.71
	843221	1.29	2.03	1.65
	843229	1.35	1.31	1.31
	843621	0.57	1.66	1.06
Disadvantages	843240	0.74	1.21	0.96
	841939	0.63	1.24	0.93
	843290	0.37	1.22	0.79
	871620	0.47	1.21	0.78
	870110	0.99	0.52	0.72
	843699	0.61	0.78	0.69
	843320	0.58	0.70	0.64
	820190	0.65	0.52	0.58
	843490	0.35	0.75	0.56
	843691	0.51	0.63	0.56
	843340	0.18	0.90	0.52
	842490	0.18	1.04	0.50
	843359	0.49	0.51	0.50
	843390	0.36	0.58	0.48
	843360	0.28	0.51	0.38
	843280	0.29	0.43	0.34
	820840	0.22	0.42	0.32
	843353	0.17	0.48	0.32
	843330	0.28	0.36	0.32
	690990	0.10	0.24	0.16
	820150	0.16	0.12	0.14
	843680	0.08	0.20	0.14
	843319	0.07	0.05	0.06
	820160	0.05	0.04	0.04
	843351	0.04	0.06	0.04
	843311	0.03	0.02	0.02

machinery and equipment product group are coded '843210', '871620' and '843352' respectively. However, despite the increase in the export performance of the product group coded '871620' in the second period, the decrease in the export performance of the product group coded '843210' should be emphasized. The noteworthy development is that, in general, the specialization levels of product groups increased in the second period and it is observed that they have a competitive advantage in exports. While specialization increased in 21 out of 24 product groups with specialization in the second period, it declined in 3 product groups. In 11 of the 15 product groups where there is no specialization, there is an improvement in specialization in the second period. No results were obtained for the product groups coded '843221', '843353' and '870110' due to the lack of import

Table 4. Vollrath's Index and Turkey's Agricultural Machinery and Equipment Group RCA Coefficients and Superiority Degrees

	PC	A	B	TM	CV
Strong Superiority	843780	16.84	26.77	21.84	28.49
	843790	5.20	5.45	5.23	26.79
	843352	6.90	3.59	5.08	50.29
	843710	4.15	4.97	4.42	33.94
Moderate Superiority	843410	4.12	3.95	3.94	37.29
	843210	2.63	3.39	2.98	32.11
	843629	1.56	3.51	2.52	47.09
Weak Superiority	843610	1.12	3.02	1.99	61.89
	870190	1.53	2.24	1.89	27.54
	843230	1.06	2.37	1.72	49.32
	843221	1.29	2.06	1.66	40.47
	843229	1.35	1.32	1.32	27.06
	843621	0.57	1.67	1.06	73.11
Disadvantages	843240	0.73	1.21	0.96	37.48
	841939	0.63	1.24	0.93	43.71
	843290	0.37	1.23	0.79	62.57
	871620	0.47	1.22	0.78	74.12
	870110	0.99	0.52	0.72	67.70
	843699	0.60	0.78	0.68	44.47
	843320	0.57	0.70	0.63	35.27
	820190	0.65	0.52	0.57	22.71
	843691	0.51	0.62	0.56	39.34
	843490	0.35	0.75	0.55	45.61
	843340	0.18	0.90	0.52	75.12
	842490	0.18	1.05	0.50	128.98
	843359	0.49	0.51	0.50	32.36
	843360	0.28	0.51	0.38	49.77
	843280	0.29	0.42	0.34	48.84
	820840	0.22	0.42	0.32	46.30
	843330	0.28	0.36	0.32	46.60
	843353	0.17	0.48	0.32	63.13
	690990	0.10	0.24	0.16	68.67
	843680	0.08	0.20	0.14	63.23
	820150	0.16	0.12	0.13	44.60
	843319	0.07	0.05	0.06	69.40
	820160	0.05	0.04	0.04	71.44
	843351	0.04	0.06	0.04	104.37
	843311	0.03	0.02	0.02	38.41
	843390	0.36	0.57	0.47	40.12

Table 5. NEI and Turkey's Agricultural Machinery and Equipment Group RCA Coefficients and Superiority Degrees

	PC	A	B	TM
There is Specialization	843210	0.97	0.94	0.96
	843221	0.89	0.98	0.95
	843780	0.86	0.93	0.90
	871620	0.76	0.89	0.84
	843352	0.81	0.78	0.80
	843790	0.71	0.83	0.78
	843240	0.54	0.80	0.68
	843230	0.27	0.69	0.48
	843290	0.22	0.73	0.48
	843330	0.52	0.38	0.47
	843410	0.38	0.49	0.45
	843280	0.25	0.53	0.42
	843610	0.17	0.54	0.36
	843699	0.28	0.39	0.35
	843629	0.21	0.47	0.34
	843229	0.10	0.27	0.19
	870190	0.16	0.21	0.18
	843320	0.00	0.19	0.09
	843691	-0.04	0.16	0.07
	843710	-0.05	0.16	0.05
	843390	-0.04	0.10	0.04
	843680	-0.28	0.31	0.02
	843490	-0.27	0.30	0.01
No Specialization	843351	-0.93	-0.89	-0.93
	843311	-0.86	-0.85	-0.86
	820150	-0.86	-0.79	-0.83
	820160	-0.77	-0.82	-0.80
	843360	-0.86	-0.67	-0.78
	690990	-0.71	-0.68	-0.70
	843319	-0.69	-0.49	-0.60
	843359	-0.43	-0.59	-0.52
	841939	-0.65	-0.29	-0.48
	842490	-0.69	-0.19	-0.47
	843340	-0.68	-0.11	-0.42
	820840	-0.58	-0.20	-0.41
	843621	-0.70	0.01	-0.37
	843353	-0.15	-0.52	-0.37
	820190	-0.12	0.10	-0.01
	870110	0.27	-0.29	-0.01

Table 6. EIRI and Turkey's Agricultural Machinery and Equipment RCA Coefficients and Superiority Degrees

	PC	A	B	TM
Competitive Advantage	843210	132.91	76.27	98.55
	871620	45.45	132.84	73.85
	843352	28.89	64.22	39.77
	843780	28.63	64.97	38.27
	843790	10.59	16.13	13.39
	843240	5.61	17.02	10.64
	843230	2.95	14.76	7.16
	843290	2.60	9.69	5.90
	843410	5.23	6.87	5.78
	843330	9.52	3.68	5.62
	843280	3.08	6.41	4.42
	843610	2.59	7.23	4.14
	843629	2.58	5.28	3.64
	843229	3.05	4.55	3.48
	843699	3.22	3.27	3.20
	870190	3.30	2.61	2.64
	843680	1.01	3.19	2.01
	843320	1.64	2.57	1.99
	843691	1.83	2.25	1.96
	843490	0.96	2.97	1.82
	843710	1.52	2.28	1.82
	843390	1.78	1.76	1.75
	820190	1.24	1.80	1.48
	843621	0.37	2.72	1.05
	820840	0.44	0.98	0.68
	843340	0.32	1.28	0.68
	842490	0.29	1.27	0.64
Competitive Disadvantage	841939	0.36	0.79	0.56
	843359	0.80	0.38	0.53
	843319	0.32	0.50	0.39
	690990	0.27	0.27	0.26
	843360	0.12	0.28	0.19
	820160	0.21	0.15	0.17
	820150	0.12	0.16	0.14
	843311	0.11	0.11	0.11
	843351	0.06	0.09	0.05
	843221	-	636.58	-
	843353	-	0.46	-
	870110	-	1.20	-

or export values.

CONCLUSION

In this study, the competitiveness of Turkey's exports of agricultural implements and equipment for the period 2002-2021 is empirically analyzed using the Explained Comparative Advantage approach. Balassa's RCA2 Index, Vollrath's RXA, NEI and EIRI were used in the analysis.

Balassa's RCA index coefficients for Turkey's exports of agricultural implements and equipment are consistent with the results of Vollrath's RXA Index. According to the results of Turkey's global export competitiveness analyzed with the RXA Index, Turkey has a competitive advantage in exports of 13 out of 39 products. Turkey has a strong competitive advantage in 4, a moderate competitive advantage in 3 and a weak competitive advantage in 6 of the 13 products. Except for the product group coded '843352' in the strong advantage group, the competitiveness of the other 3 product groups increased in the second period. In addition, the arithmetic average of the RCA values of 9 product groups, 3 of which

have medium and 6 of which have weak competitive advantage, and 20 product groups with competitive disadvantage, are higher in the second period compared to the first period. These findings indicate an increase in the competitiveness of the sector. It is also evidence of the success of the policies implemented.

According to the NEI results on Turkey's own trade performance and specialization level, Turkey has specialized in exports of 23 out of 39 product groups, while it has not specialized in 16. A very important development for the agricultural machinery and equipment sector is the decrease in imports in 12 of the 16 product groups in which it is an importer. It is noteworthy that most of the product groups of the agricultural machinery and equipment sector increased their level of specialization in the second period and had a competitive advantage. According to the results of the EIRI, which measures the level of specialization, Turkey specialized in the exports of 23 product groups, while it did not specialize in the exports of 13 product groups. However, the high rate of decline in specialization levels in the second period is noteworthy. The 3 product groups with the highest level of specialization in Turkey's exports of agricultural tools and equipment are coded '843210', '843352' and '843780', respectively.

The findings of the study show that Turkey's export competitiveness in the agricultural machinery and equipment product group has increased over time despite increasing global competition. In order to ensure continuity in increasing competitiveness, it may be a better approach to focus on factors that will provide competitive advantage such as R&D and marketing instead of focusing on production and cost control. Policies to accelerate technological progress and the creation of attractive conditions for foreign investments that can create technology transfer can be effective in increasing competitiveness. In addition, it may be useful to make the necessary planning for the training of the labor force that will create technological progress. Considering the dependence on imports in the production of exported products in the Turkish economy, a stable exchange rate policy will be effective in increasing exports.

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Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

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