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COMPARATIVE ANALYSIS OF THE COMPETITIVENESS IN THE STEEL SECTOR: THE CASE OF TOP 10 STEEL-PRODUCING COUNTRIES

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ABSTRACT

Besides being one of the most developed sectors in Turkey, the steel sector is an important sector that contributes to the country's economy. In this study, it is aimed to analyze the competitiveness of steel exports of the top 10 steel-producing countries. In this context, the Revealed Comparative Advantage (RCA) index, the Revealed Symmetric Comparative Advantage (RSCA) index and the Trade Balance Index (TBI) were calculated. In addition, in this study, a production mapping was created by using the combination of TBI and RSCA index values of the top 10 steel-producing countries. Finally, the Comparative Export Performance Index (CEP) has been calculated for Turkey's exports of finished and semi-finished steel products to countries (China, India, Japan, Russia) that have a comparative advantage according to the result of RCA analysis. The findings obtained in the study show that Turkey is an important country in the world trade in the finished and semi-finished steel sectors. It has been observed that Turkey is in an advantageous position in every index calculated in the steel industry.

Keywords: Revealed Comparative Advantage, Steel Sector, Comparative Export Performance, Production Mapping.

Jel Codes: F10, F14.

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ÇELİK SEKTÖRÜNDE REKABET GÜCÜNÜN KARŞILAŞTIRMALI ANALİZİ: ÇELİK ÜRETEN İLK 10 ÜLKE ÖRNEĞİ

ÖZ

Çelik sektörü, Türkiye'nin en gelişmiş sektörlerinden biri olmasının yanısıra ülke ekonomisine katkı sağlayan önemli bir sektör konumundadır. Bu çalışmada ilk 10 çelik üreticisi ülkenin çelik ihracatındaki rekabet gücünün analiz edilmesi amaçlanmıştır. Bu bağlamda Açıklanmış Karşılaştırmalı Üstünlük (RCA) endeksi, Açıklanmış Simetrik Karşılaştırmalı Üstünlükler (RSCA) endeksi ve Ticaret Dengesi İndeksi (TBI) hesaplanmıştır. Ayrıca bu çalışmada, ilk 10 çelik üreticisi ülkenin TBI ve RSCA endeks değerlerinin kombinasyonu kullanılarak üretim haritası oluşturulmuştur. Son alarak Türkiye'nin, RCA analizi sonucuna göre karşılaştırmalı üstünlüğe sahip olan ülkelerle (Çin, Hindistan, Japonya, Rusya) işlenmiş ve yarı işlenmiş çelik ürünleri ihracatında Karşılaştırmalı İhracat Performans Endeksi (CEP) hesaplanmıştır. Çalışmada elde edilen bulgular, Türkiye'nin mamul ve yarı mamul çelik sektöründe dünya ticaretinde önemli bir ülke olarak yer aldığını göstermektedir. Türkiye'nin çelik sektöründe hesaplanan her endekste avantajlı bir konumda olduğu gözlemlenmiştir.

Anahtar Kavramlar: Açıklanmış Karşılaştırmalı Üstünlük, Çelik Sektörü, Karşılaştırmalı İhracat Performansı, Üretim Haritası .

Jel Kodları: F10, F14.

INTRODUCTION

In 1856, Henry Bessemer invented the process of turning iron into steel. But the rise of steel began with the 19th century Industrial Revolution in Europe and North America. Steel has played a life-facilitating role throughout human history. The World Steel Association (WSA) defines steel as the world's most important engineering and construction material. Despite being extremely energy-intensive to manufacture, steel has high durability and can also be used repeatedly and fully recycled after steel has been produced. With a global recovery rate of over 70%, steel is the most recycled material on the planet 97% of the by-products obtained from steel production can be reused (World Steel Association [WSA], 2012).

A strong steel sector underpins many industrial value chains such as construction and infrastructure development, and raw material-dependent sectors such as machinery and hardware, chemicals, metal products, shipbuilding, automotive and aerospace industries. In addition, the steel industry, which is considered a very important basic industry for the development of modern industrialized economies, is also accepted as an indicator of economic development (Cerasa and Buscaglia, 2019, p. 241).

Steel products are intermediate goods used in a wide variety of important industries, from construction to white goods, automobiles and other transportation equipment, energy and defense. Many steel products are used by sub-sectors

domestically. However, steel is exported to be used as an input in the production of goods. In addition, while raw materials for steel production and other inputs required for the production of steel products are abundant in some countries, some need to obtain these resources from abroad. The steel sector is also of great importance for the economy due to its characteristics such as the widespread use of steel products, the increasing consumption of steel products, the production of intermediate goods for the manufacturing industry and its export potential (Ersöz, Düğenci, Ünver and Eyiol, 2015, p. 76). As a result, steelmaking activities link different economies through the trade of both steel inputs and outputs (Mattera, 2018, p. 24). Steel trade is largely determined by the comparative advantage of steel-producing countries. The stronger the relative trade performance of an economy in a particular product or sector, the greater the comparative advantage that country has in the production of that product or sector (Carvalho and Sekiguchi, 2015, p. 27).

The aim of this study is to determine the competitiveness of the top 10 steel-producing countries in exports of finished and semi-finished steel products for the period 2010-2019. In the study, Balassa's Revealed Comparative Advantage (RCA) Index, Revealed Symmetric Comparative Advantage (RSCA) Index and Trade Balance Index (TBI) were used to determine the competitiveness of steel exports of the top 10 steel-producing countries. In addition, the Comparative Export Performance Index CEP was calculated for Turkey's exports of finished and semi-finished steel products with the countries determined to have a comparative advantage according to the result of the RCA analysis.

Although there are studies in the literature to determine the competitiveness of the iron and steel industry, there are few studies to measure the international competitiveness of the finished and semi-finished steel industry. This study differs from other studies as it deals with exports of finished and semi-finished steel.

The study consists of four sections. In the first section after the introduction, information will be given about the general view of the Turkish iron and steel industry. In the second section, previous empirical studies on the subject will be given. In the third section, information and analysis results about the method and data set of the study will be presented. The final section will include general conclusions and recommendations.

I.OVERVIEW OF TURKEY IN THE STEEL INDUSTRY

The world's total steel production[1] is increasing due to the high share of the steel industry in world trade, the high employment of labor[2], the increase in total economic activities throughout the world, and the increase in the demand for

[1]According to the World Steel Association, it was 162.9 million tons (Mt) in January 2021.
[2]Globally, more than 6 million people work in the steel industry (WSA, 2021).

housing, automobile and automobile sub-industry, machinery and equipment, white goods and other iron and steel products.

Global crude steel production reached 1,864.0 million tons (Mt) for 2020 (WSA,2021). As the largest steel producer, China's crude steel output in 2020 is 1,053.0 Mt and China's share of global crude steel production is 56.5% in 2020. Turkey's 2020 crude steel production was 35.8 million tons in 2020 (WSA, 2021). The World Steel Association forecasts steel demand to rise 5.8% to 1,874.0 million tons (Mt) in 2021, following a 0.2% decline in 2020. In 2022, steel demand is expected to increase by 2.7 percent to 1,924.6 Mt (WSA SRO, 2021).

Being one of the most developed sectors in Turkey, the steel sector is the fourth largest sector contributing to the country's economy after automotive, chemistry and textile. According to 2020 data, the share of the steel industry in total exports is 7.4% (Steel Exporters' Association, 2020).

Table 1: Top 10 Steel-producing Countries

Countries	**million tonnes**			**y-o-y growth rates (%)**		
	2020	**2021***	**2022***	**2020**	**2021***	**2022***
China	995.0	1,024.9	1,035.1	9.1	3.0	1.0
India	88.5	106.1	112.3	-13.7	19.8	5.9
United States	80.0	86.5	90.2	-18.0	8.1	4.3
Japan	52.6	56.0	58.8	-16.8	6.5	5.0
South Korea	49.0	51.5	52.8	-8.0	5.2	2.5
Russia	42.5	43.8	45.1	-2.3	3.0	3.0
Germany	31.1	34.0	35.8	-11.6	9.3	5.3
Turkey	29.5	35.0	37.0	13.0	18.7	5.7
Vietnam	23.3	24.5	26.3	-4.2	5.0	7.6
Mexico	21.7	23.4	24.6	-11.8	7.5	5.5

Note: finished steel products, * forecast
Source: Short Range Outlook April 2021, WSA

According to the World Steel Association (WSA) 2020 data in Table 1, the top 10 countries in finished steel production are China, India, USA, Japan, South Korea, Russia, Germany, Turkey, Vietnam and Mexico, respectively. Turkey is the world's 8th largest producer of finished steel products in 2020. Steel production in Turkey increased by 13% in 2020, reaching the level of 29.5 million tons (WSA WSF, 2020).

From the estimated steel production data for 2021 and 2022 in Table 1, it is seen that the increase in Turkey's steel production will continue and Turkey will leave Germany behind. On the other hand, according to 2020 data and 2021-2022 forecasts, it is noteworthy that Turkey's steel production growth rate is even higher than that of China, the world's largest steel producer.

Table 2: Major steel importers and exporters 2020

Sıra	Total exports	Mt	Total imports	Mt
1	China	51.4	China	37.9
2	Russia	31.5	European Union (28) (1)	32.6
3	Japan	29.8	United States	19.9
4	South Korea	27.6	Germany (2)	18.2
5	European Union (28) (1)	22.6	Italy (2)	15.5
6	Germany (2)	21.2	Vietnam	13.6
7	**Turkey**	18.5	**Turkey**	12.5
8	India	17.1	France (2)	11.8
9	Ukraine	15.2	South Korea	11.5
10	Italy (2)	14.9	Poland (2)	10.8

Note: (1) Excluding intra-regional trade (2) Data for individual European Union (28) countries include intra-European trade
Source: 2021 World Steel in Figures, WSA

Table 2 shows the major steel exporters and importers according to 2020 data. The country that ranks first in both steel exports and steel imports is China, the largest steel producer. Turkey, on the other hand, ranks 7th in steel exports and imports.

II. LITERATURE REVIEW

In the literature, the competitiveness of the iron and steel industry has generally been analyzed together with other sectors, and the number of studies aimed at measuring the international competitiveness of only the iron and steel industry or the steel industry is limited. Some of the studies in the literature that have been made to measure the international competitiveness of the iron and steel sector or only the steel sector with the Revealed Comparative Advantage Analysis (RCA) can be summarized as follows:

Carvalho and Sekiguchi (2015) examined the changes in steel exports of the ten largest steel-producing countries between 2004 and 2014 in terms of exported steel products and the market target for these exports. While Ukraine and Russia are the most specialized countries in semi-finished steel products, Turkey is the most specialized country with its high RCA index in bars. RCA indexes of China and EU have also been moving upwards in recent years.

Kara and Erkan (2016) analyzed the relationship between Turkey's productivity level in the iron and steel industry and the comparative advantage in exports of this industry for the period 2000-2009. In the study, the "Revealed Comparative Advantage (ACU) coefficients" related to the sector were determined by the Balassa Index. According to the Balassa Index in the study, it was concluded that the sector generally has a moderate comparative advantage. In addition, a

positive relationship was found between the efficiency level of the iron and steel industry and its comparative advantage.

Fojtíková (2017) used the Revealed Comparative Advantage (RCA) index to detect changes in the comparative advantage of China's exports of steel products over the period 2001-2016. The results of the analysis showed that the competitiveness of steel exports in China is higher in "Iron and Steel Products" than in "Iron and Steel".

Türker (2017) concluded that Turkey had a comparative advantage in the iron and steel industry in the 1986-2016 period, but the competitive index value, which was higher in the first years, decreased in the following years.

Çeştepe and Tunçel (2018) examined the competitiveness of the Turkish iron and steel industry against the world based on three-digit sub-sectors for the period 2007-2016. They calculated the Balassa and Vollrath indexes separately and compared the results with each other. They concluded that Turkey's competitive power is low in the flat iron and steel products group used in the production of high value-added products, whereas it has high competitiveness in the long iron and steel products group with low added value.

Mattera (2018) compared RCA values in 2004 and 2014 for China, Japan, EU28, Korea, Russia, Ukraine, Turkey, Taiwan, United States, and India. Mattera (2018) revealed the change over time in the specialization patterns in semi-finished products, profiles, bars, wire rods, plates (carbon steel), HRC (carbon steel), which are the steel sub-sectors of the countries. The results obtained in the study show that Turkey has a comparative advantage in semi-finished products, profiles, bars, but has a high advantage in bars in both years. It is noteworthy that in 2014, China had superiority in semi-finished products. On the other hand, Russia and Ukraine also have a high advantage in semi-finished products.

Fidan (2020) analyzed whether Turkey has a competitive advantage over the world's major exporter countries (Germany, Italy, France, Poland, Czech Republic, Austria and Netherlands) included in the analysis by using Balassa and Vollrath indexes for the iron or steel goods group for the period 2001-2018. According to the calculated Balassa and Vollrath indices; Turkey has an international comparative advantage in the export of iron or steel articles. As a result of the Balassa index, Turkey has a competitive advantage over France and the Netherlands; The Vollrath index, on the other hand, showed that Turkey has a competitive advantage over Germany, France, Poland, Czech Republic, Austria and the Netherlands.

Kesgingöz, Yeldan and Güçlü (2020), has investigated whether Turkey has competitiveness in global foreign trade in chapters 72 and 73, using the method of comparative advantages for the iron and steel sector. As a result of the analysis, it has been determined that Turkey is superior in foreign trade in sections 72 and 73 according to the RCA index in iron and steel sector. In addition, the RSCA index

showed that Turkey has a competitive power in the iron and steel industry. The result of the Trade Balance Index (TBI) also shows that Turkey is in the position of a net importer in foreign trade in Chapter 72 and a net exporter in Chapter 73. In the product map created with the RSCA and TBI index values, the 72nd section generally has a competitive advantage but is a net importer. In Chapter 73, however, Turkey has a competitive advantage but is a net exporter.

III. METHOD

In this study, the Revealed Comparative Advantage (RCA) analysis was used to determine the competitiveness of steel exports of the top 10 steel-producing countries. In this context, by calculating the Balassa Index and interpreting it according to a quadruple classification of the RCA index in Hinloopen and Marrewijk (2001), the competitiveness of the top 10 steel-producing countries in steel exports in global markets has been tried to be revealed. In addition, in this study, the Revealed Symmetric Comparative Advantage (RSCA) index and the Trade Balance Index (TBI) were calculated for the top 10 steel-producing countries, and a simple matrix called the production map was created by using the combination of these two indices.

In addition, the Comparative Export Performance index (CEP) of Turkey and other countries among the top 10 steel-producing countries that have a comparative advantage according to the RCA index calculation was calculated. The steel data in the study are for the period 2010-2019 and are taken from the World Steel Association (2020) Steel Statistical Yearbook 2020 Short version. The export data are taken from the World Trade Organization database.

A. REVEALED COMPARATIVE ADVANTAGE INDEX

Balassa (1965) developed the revealed comparative advantage index (RCA), which is widely used in the literature, to determine the competitiveness of countries in international trade. This approach, proposed by Liesner (1958) and developed by Balassa (1965), compares a country's share of exports in a particular product or sector with the export share of that product or sector in the world market (Gordeev, 2020, p.3). The RCA index, also called the Balassa Index, aims to explain whether there is an apparent advantage difference between countries without going into the reason for the comparative advantage (Seymen, 2009, p.237). This Index evaluates the relative performance of exports to reveal whether a country has comparative advantages or disadvantages in producing a particular good. Comparative advantage (RCA) is a theory created to provide insight into the export activity of a country or industry, based on how that activity compares with that of one or more similar entities (Rossato et. al., 2018, p.61).

The RCA Index expresses the ratio of the share of any good (sector) in the country's total exports to the share of that good (industry) in the world's (a country or region's) total exports (Erkan, 2012, p.198). RCA index values range from

zero to infinity. The RCA index is shown in equation (1) (Balassa, 1965, p. 99-123):

$$RCA_{it}^{j} = \frac{\left(X_{it}^{j}\right)}{\left(X_{t}^{j}\right)} / \frac{\left(X_{it}^{w}\right)}{\left(X_{t}^{w}\right)} \quad (1)$$

RCA_{it}^{j} : RCA index for product (sector) *i* of country *j* in year *t*

$\left(X_{it}^{j}\right)$: Export of product (sector) *i* of country *j* in year *t*

$\left(X_{t}^{j}\right)$: Total exports of country *j* in year *t*

$\left(X_{it}^{w}\right)$: Export of product (sector) *i* of the world in year *t*

$\left(X_{t}^{w}\right)$: World total exports in year *t*

If RCA_{it}^{j} >1, country *j* has a comparative advantage in goods *i* in year *t*. That is, the share of that good in the country's total exports is greater than its share in world trade. If RCA_{it}^{j} <1, country *j* has a comparative disadvantage in goods *i* in year *t*. If RCA_{it}^{j} = 1, country *j* has a comparative disadvantage in goods *i* in year *t*.

Hinloopen and Marrewijk (2001) made a quadruple classification for a more detailed interpretation of the RCA index. According to the classification of Hinloopen and Marrewijk (2001), 0 <RCA≤ 1 shows that there is no comparative advantage. 1 < RCA ≤ 2 means "weak" comparative advantage, 2 < RCA ≤ 4 "moderate" comparative advantage and 4 < RCA "strong" comparative advantage" (Erkekoğlu, Kılıçarslan and Göknar, 2014).

Table 3 presents the results of the RCA analysis conducted to determine the competitiveness of the Top 10 steel-producing countries in steel exports. According to the results in Table 3, the RCA index values of the USA, South Korea, Germany, Vietnam and Mexico are less than one. Although these countries are among the top 10 steel producers in the analysis period, they do not have a comparative advantage in steel exports in the period of 2010-2019. On the other hand, China, India, Japan, Russia and Turkey, whose RCA index values are greater than one, are the countries that have a comparative advantage in steel exports.

Table 3: RCA Analysis of finished and semi-finished steel products exports of top 10 steel-producing countries

Years	China	India	USA	Japan	S.Korea	Russia	Germany	Turkey	Vietnam	Mexico
2010	1.03	1.15	0.36	2.16	0.25	2.66	0.78	5.55	0.37	0.68
	W	W	N	M	N	M	N	S	N	N
2011	1.11	1.29	0.39	2.16	0.20	2.08	0.78	5.42	0.51	0.69
	W	W	N	M	N	M	N	S	N	N
2012	1.19	1.23	0.39	2.31	0.18	2.24	0.82	5.42	0.50	0.56
	W	W	N	M	N	M	N	S	N	N
2013	1.28	1.47	0.36	2.73	0.16	2.08	0.77	4.92	0.48	0.68
	W	W	N	M	N	M	N	S	N	N
2014	1.65	1.34	0.31	2.49	0.17	2.35	0.69	4.00	0.42	0.56
	W	W	N	M	N	M	N	M	N	N
2015	1.74	1.00	0.24	2.31	0.15	3.08	0.67	3.49	0.33	0.36
	W	W	N	M	N	M	N	M	N	N
2016	1.73	1.31	0.21	2.11	0.15	3.72	0.64	3.46	0.48	0.37
	W	W	N	M	N	M	N	M	N	N
2017	1.27	2.09	0.25	2.06	0.17	3.38	0.70	3.81	0.72	0.48
	W	M	N	M	N	M	N	M	N	N
2018	1.18	1.45	0.22	2.07	0.20	3.20	0.71	4.77	0.94	0.55
	W	W	N	M	N	M	N	S	N	N
2019	1.10	1.77	0.19	2.02	0.34	3.02	0.69	4.67	0.85	0.48
	W	W	N	M	N	M	N	S	N	N

Note: W: Weak, M: Moderate, S: Strong, N: No
Source: The table created by the author using data from the World Steel Association.

RCA index values were interpreted according to the classification of Hinloopen and Marrewijk (2001), and countries with "weak", "moderate" and "strong" revealed comparative advantage and countries with comparative disadvantage were determined. Accordingly, it is noteworthy that Turkey is the only country with a "strong" comparative advantage among the countries participating in the analysis. Although the largest steel exporter is China, Turkey has the highest RCA Index score. Turkey is the country with the biggest comparative advantage among the top 10 steel-producing countries. As seen in Table 3, while Turkey has a "strong" comparative advantage in the steel industry in 2010, 2011, 2012, 2013, 2018 and 2019, it has a "moderate" comparative advantage in 2014, 2015, 2016, 2017 and 2018. Japan and Russia have a “moderate” comparative advantage throughout the analysis period. China has a “weak” comparative advantage throughout the analysis period. India has a

"moderate" comparative advantage in 2017 and a "weak" comparative advantage in other years.

B. REVEALED SYMMETRIC COMPARATIVE INDEX

The Revealed Symmetric Comparative Advantages (RSCA) index is an enhanced version of the RCA method. The fact that the RCA index takes a value between zero and infinity makes the index asymmetrical. Therefore, the RCA index needs to be adjusted so that it becomes symmetrical when using it. For this adjustment, Dalum, Laursen and Villumsen (1998) and Laursen (1998) proposed the Revealed Symmetric Comparative Advantage index for the calculation of comparative advantage (Widodo, 2009,p.68). The RSCA index corrects for asymmetry regarding the extent of revealed comparative advantages or disadvantages This index is shown in equation 2 (Rossato et. al.,2018, p.61):

$$RSCA_{it}^{j} = \left(RCA_{it}^{j} - 1\right)/\left(RCA_{it}^{j} + 1\right) \quad (2)$$

The $RSCA_{it}^{j}$ shows the revealed symmetric comparative advantage index in the goods (sector) i of country j in period t. The $RSCA$ value ranges from -1 to +1 ($-1 \leq RSCA \leq 1$). If the RSCA Index value is positive, the relevant product, sector or country has a comparative advantage according to the competitiveness, while if the index value is negative, the comparative disadvantage is valid for the relevant product, sector or country competitiveness (Laursen, 1998).

Table 4: RSCA Analysis of finished and semi-finished steel products exports of top 10 steel-producing countries

Years	China	India	USA	Japan	S.Korea	Russia	Germany	Turkey	Vietnam	Mexico
2010	0.01	0.07	-0.47	0.37	-0.60	0.45	-0.12	0.69	-0.45	-0.19
2011	0.05	0.13	-0.44	0.37	-0.66	0.35	-0.12	0.69	-0.32	-0.18
2012	0.09	0.10	-0.44	0.40	-0.69	0.38	-0.10	0.69	-0.34	-0.28
2013	0.12	0.19	-0.47	0.46	-0.73	0.35	-0.13	0.66	-0.35	-0.19
2014	0.24	0.14	-0.53	0.43	-0.71	0.40	-0.18	0.60	-0.41	-0.28
2015	0.27	0.00	-0.62	0.40	-0.74	0.51	-0.20	0.55	-0.50	-0.47
2016	0.27	0.14	-0.65	0.36	-0.74	0.58	-0.22	0.55	-0.35	-0.46
2017	0.12	0.35	-0.60	0.35	-0.71	0.54	-0.18	0.58	-0.16	-0.35
2018	0.08	0.19	-0.64	0.35	-0.67	0.52	-0.17	0.65	-0.03	-0.29
2019	0.05	0.28	-0.68	0.34	-0.49	0.50	-0.18	0.65	-0.08	-0.35

Source: The table was created by the author.

Table 4 contains the results of the RSCA analysis of the top 10 steel-producing countries. The RSCA results clearly show that China, India, Japan, Russia, Turkey have comparative advantage and USA, South Korea, Germany,

Vietnam and Mexico have comparative disadvantage. According to the RSCA results, the country with the highest comparative advantage is Turkey.

C. TRADE BALANCE INDEX

Trade Balance Index (TBI) is applied as a complement to the RSCA analysis in the literature (Girik Allo, Sukartini and Widodo, 2017, p.4). The Trade Balance Index (TBI), developed by Lafay (1992), is used to determine whether a country is a net exporter or a net importer of the relevant product (Miteva-Kacarski, 2018, p.62). However, the Trade Balance Index explains a country's trade pattern better than indexes based solely on export data (Lafay, 1992). The Trade Balance Index (TBI) is calculated as in equation 3:

$$TBI_{it}^{j} = \frac{\left(X_{it}^{j} - M_{it}^{j}\right)}{\left(X_{it}^{j} + M_{it}^{j}\right)} \tag{3}$$

TBI_{it}^{j}, TBI index for product (sector) *i* of country *j* in year *t*

$\left(X_{it}^{j}\right)$: Export of product (sector) *i* of country *j* in year *t*

$\left(M_{it}^{j}\right)$: Import of product (sector) *i* of country *j* in year *t*

The Trade Balance Index value ranges from -1 to +1. If the value of the TBI index is $0 < TBI \leq 1$, the country is a net exporter. If the value of this index is $(-1 \leq TBI < 0)$ the country is a net importer. If the value of this index is equal to 0, it means that the country's export value and import value are the same (Widodo, 2008, p. 204). Negative values of this index indicate that imports are more important in that product (or sector) and that the country has a competitive disadvantage in that product (or sector); positive values of this index indicate that exports are more important and that the country is more competitive than the average in that product (or sector) (Caporale, Sova and Sova, 2015, p. 263).

The Trade Balance Index results of the top 10 steel-producing countries are presented in Table 5. According to the results in Table 5, while the USA, South Korea, Vietnam and Mexico are net importers in the finished and semi-finished steel products sector in the 2010-2019 period, China, Japan and Russia are net exporters. India has changed from being a net importer in 2010, 2011, 2012 and 2015 to a net exporter in other years. Germany is a net importer in 2016, 2017 and 2018, and a net exporter in other years. Finally, while Turkey is a net importer country in 2015 and 2016, it is a net exporter in other years.

Table 5: Trade Balance Index of finished and semi-finished steel products sector of top 10 steel-producing countries

Countries	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
China	0.42	0.49	0.59	0.61	0.72	0.79	0.78	0.69	0.65	0.61
India	-0.19	-0.02	-0.06	0.15	0.05	-0.27	0.02	0.3	0.1	0.2
USA	-0.31	-0.33	-0.39	-0.41	-0.55	-0.57	-0.54	-0.55	-0.57	-0.58
Japan	0.81	0.76	0.76	0.77	0.72	0.75	0.74	0.71	0.71	0.67
S.Korea	-0.78	-0.8	-0.8	-0.82	-0.81	-0.82	-0.83	-0.77	-0.68	-0.58
Russia	0.68	0.55	0.59	0.57	0.63	0.74	0.75	0.65	0.68	0.62
Germany	0.05	0.03	0.06	0.05	0.01	0.01	-0.02	-0.01	-0.01	0.02
Turkey	0.2	0.24	0.24	0.09	0.09	-0.11	-0.05	0.02	0.17	0.23
Vietnam	-0.86	-0.75	-0.72	-0.76	-0.78	-0.83	-0.77	-0.6	-0.45	-0.49
Mexico	-0.13	-0.11	-0.33	-0.18	-0.26	-0.44	-0.41	-0.38	-0.31	-0.38

Source: The table was created by the author.

D. PRODUCTION MAPPING

Widodo (2008) transformed the flying geese model and boomerang effect into a production mapping (Girik Allo et. al., 2017, p.9). The flying geese paradigm was developed by Kaname Akamatsu (Korhanen, 1994, p. 94). By adding another stage called the "boomerang effect," Shinohara presented Akamatsu's original Flying Geese model to the Western academy for the first time (Kojima, 2000, p.391).

The production mapping is created using the combination of the RSCA index and the TBI index. the Production mapping is divided into four groups as A, B, C, D. These groups are expressed as follows (Widodo, 2008):

Group A: Comparative Advantage-Net Exporter (RSCA>0, TBI>0).
Group B: Comparative Advantage-Net Importer (RSCA >0, TBI <0).
Group C: Comparative Disadvantage-Net Exporter (RSCA <0, TBI>0).
Group D: Comparative Disadvantage-Net Importer (RSCA <0, TBI<0).

The production mapping created by using the combination of RSCA index and TBI index values for the semi-finished and finished steel products sector of the top 10 steel-producing countries is given in Table 6.

Table 6: Production mapping of finished and semi-finished steel products sector of top 10 steel-producing countries

Years	China	India	USA	Japan	S.Korea	Russia	Germany	Turkey	Vietnam	Mexico
2010	A	B	D	A	D	A	C	A	D	D
2011	A	B	D	A	D	A	C	A	D	D
2012	A	B	D	A	D	A	C	A	D	D
2013	A	A	D	A	D	A	C	A	D	D
2014	A	A	D	A	D	A	C	A	D	D
2015	A	D	D	A	D	A	C	B	D	D
2016	A	A	D	A	D	A	D	B	D	D
2017	A	A	D	A	D	A	D	A	D	D
2018	A	A	D	A	D	A	D	A	D	D
2019	A	A	D	A	D	A	C	A	D	D

Source: The table was created by the author.

As can be seen from Table 6, China, Japan and Russia are in group A because they have a comparative advantage in finished and semi-finished steel products and are net exporters in all years. The USA, South Korea, Vietnam and Mexico have both a comparative disadvantage and a net importer position in the finished and semi-finished steel industry in all years and are in the D group. Turkey has a comparative advantage throughout the analysis period. However, while it is a net importer country in 2015 and 2016, it is a net exporter in other years. In other words, it is in the B group in 2015 and 2016, and in the A group in other years. The years 2015 and 2016, when Turkey was in group B, were the years in which it had a moderate comparative advantage according to the classification of Hinloopen and Marrewijk (2001). While Germany has both a comparative disadvantage and a net importer in the 2016-2018 period, it is a net exporter despite having a comparative disadvantage in other years. India is a having comparative advantage and net importer of steel in the period 2010-2012, while it is a comparative disadvantage and net importer only in 2015, it is a having comparative advantage and net exporter in other years.

When the results in Table 6 are evaluated as a whole, it is seen that countries with comparative advantage in finished and semi-finished steel products are not always net exporters, since the relevant sector is not considered in terms of sub-sectors. That is, since a product group is used instead of a specific product in the analysis, it is possible for a country to export and import a group of products at the same time. Thus, a country may be a "net exporter" of products for which it apparently has a "comparative disadvantage" (Widodo, 2009; Ishchukova and Smutka, 2013).

E. COMPARATIVE EXPORT PERFORMANCE INDEX

The Comparative Export Performance Index (CEP) was adapted from the Balassa Index by Donges et al. (1982). This index is used to measure the sectoral competitiveness of a country against a competitor country(s) and provides the opportunity to compare the competitiveness of countries in certain goods groups (Şahin, 2016, p.711; Kuşat, 2019, p. 149). The Comparative Export Performance Index (CEP) is calculated as follows:

$$CEP_{it}^{j} = \frac{(X_{it}^{j} / X_{it}^{r})}{(X_{t}^{j} / X_{t}^{r})} \tag{4}$$

CEP_{it}^{j} = Comparative export performance index coefficient of country j versus competitor country in product group i

X_{it}^{j} = Export of product (sector) i of country j in year t

X_{it}^{r} = Export of product (sector) i of competitor country's (r) in year t

X_{t}^{j} = Total exports of country j in year t

X_{t}^{r} = Total exports of competitor country (r) in year t

The country with the higher CEP index has a comparative advantage over the other (Alidou, Ceylan and Ilbasmiş 2018, p.391). If the CEP index value is greater (smaller) than 1, the country has an advantage (disadvantage) in the export of that good against the rival country. A value of this index greater than 1 means that a particular good has a larger share in the total product exports of an individual country than in the world trade as a whole. Therefore, the country has a relative advantage in the manufacture and export of this good. The reverse is true for index values less than 1 (Donges, Krieger-Boden, Langhammer, Schatz and Thoroe, 1982, p. 83).

Table 7 shows the Comparative Export Performance Index (CEP) values calculated for the export of finished and semi-finished steel products of countries (China, India, Japan, Russia) and Turkey, which have a comparative advantage according to the results of the RCA analysis. From Table 7, it is seen that Turkey's CEP index values are greater than 1 compared to other four countries. In the CEP analysis, it is seen that Turkey maintains its comparative advantage in the RCA analysis. When Turkey's competitiveness is compared against rival countries, the country with the highest competitive advantage is China, which is the largest steel producer country.

Table 7: Comparative Export Performance Index of Turkey in finished and semi-finished steel products sector

Years	China	India	Japan	Russia
2010	5.40	4.82	2.57	2.08
2011	4.90	4.19	2.50	2.61
2012	4.56	4.39	2.35	2.42
2013	3.85	3.35	1.80	2.37
2014	2.43	2.99	1.61	1.70
2015	2.01	3.49	1.51	1.13
2016	2.00	2.63	1.64	0.93
2017	3.01	1.82	1.85	1.13
2018	4.05	3.28	2.31	1.49
2019	4.26	2.64	2.32	1.55

Source: The table was created by the author.

CONCLUSIONS AND RECOMMENDATIONS

In this study, which aims to analyze the competitiveness of the steel export of the top 10 steel-producing countries, first Revealed Comparative Advantage (RCA) analysis, Revealed Symmetric Comparative Advantage (RSCA) analysis, Trade Balance Index (TBI) analysis were performed. In addition, the results of the RCA index were reinterpreted according to the Hinloopen and Marrewijk (2001) classification. Additionally, in this study, a production map was created using the combination of RSCA and TBI of the top 10 steel-producing countries. Finally, the Comparative Export Performance Index (CEP) was calculated for Turkey's exports of semi-finished and finished steel products to countries (China, India, Japan, Russia) that have a comparative advantage according to the RCA analysis.

According to the results of the RCA analysis, China, India, Japan, Russia and Turkey are the countries that have a comparative advantage in steel exports. According to the classification of Hinloopen and Marrewijk (2001), Turkey is the only country with a "strong" comparative advantage among the countries participating in the analysis. The RSCA analysis results clearly show the comparative advantage of China, India, Japan, Russia, Turkey and the comparative disadvantage of the USA, South Korea, Germany, Vietnam and Mexico. The RSCA analysis results support the RCA analysis results.

According to the TBI analysis results, while the USA, South Korea, Vietnam and Mexico are "net importing countries" in the 2010-2019 period, China, Japan and Russia are "net exporting countries". While India is a "net importing country" in 2010, 2011, 2012 and 2015, it is a "net exporting country" in other years. Germany is a "net importer" in the steel industry in 2016, 2017 and 2018,

and a "net exporter" in other years. Lastly, while Turkey is a "net importer country" in 2015 and 2016, it is a "net exporter" in other years.

In the production mapping created using the combination of RSCA and TBI, China, Japan and Russia in the finished and semi-finished steel products sector in all years. They are in group A because they have a comparative advantage and are net exporters. The USA, South Korea, Vietnam and Mexico have both a comparative disadvantage and a net importer position in the finished and semi-finished steel industry in all years and are in the D group. While Turkey has a comparative advantage and is a net importer country in 2015 and 2016, it is in the B group. In other years, it is in group A both as a country with comparative advantage and as an exporting country.

CEP results show that Turkey has CEP index values greater than 1 compared to the other four countries (China, India, Japan, Russia). It is seen that Turkey maintains its comparative advantage in the RCA analysis according to the results of the CEP analysis.

The findings obtained in the study are compatible with the results of Carvalho and Sekiguchi (2015) regarding Turkey. The findings obtained in the study show that Turkey is an important country in the world trade in the finished and semi-finished steel products sector. It is seen that Turkey is in an advantageous position in every index calculated in the steel industry. In order to maintain its competitive advantage, the development of new products in the steel industry and activities that will increase energy efficiency should be supported.

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