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Electronics Industry Competitiveness Analysis and Export Potential Mapping Using Biplot Analysis

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ABSTRACT: The purpose of this study is to analyse the competitiveness of electronics commodity exports in the international market and to map the potential of electronics commodities based on the main export destination countries and electronics producing countries as a comparison. This study uses the competitiveness method using the RCA method for 7 countries with high competitiveness rankings in the global market while biplot analysis is used to determine the map of Indonesia's export potential to 10 main export destination countries based on the electronics and telematics industry sub-sectors. The RCA results show that Brazil and South Africa have an RCA of more than 1. So that, Indonesia has high competitiveness in industrial products of computer goods, electronic goods, optics and electrical equipment to South Africa and Brazil based on RCA values greater than 1. Based on the results of biplot analysis, it is known that Australia, Philippine, and Germany have similar characteristics. This research is also expected to provide policy recommendations regarding the description of the competitiveness of electronics exports and the potential to increase the export value of the electronics industry based on its industrial sub-sectors.

KEYWORDS: Competitiveness, Electronics, Export, Biplot, RCA

I. INTRODUCTION

International trade can support the country's economy, increase the country's source of income, expand labor opportunities and can also accelerate the application of technology to facilitate industrial activities. Economic integration based on the need for free trade with minimal barriers, has resulted in the formation of organizations capable of providing facilities for goods, services and money, such as the World Trade Organization (WTO), International Monetary Fund (IMF), North American Free Trade Area (NAFTA), South East Asian Association (ASEAN) (Nadrag & Bala, 2014).The form of international trade activities is in the form of exports and imports. According to Law No. 17/2006 on customs, export is the activity of removing goods from the customs area. Meanwhile, import is the activity of bringing goods into the customs area. Exports enable a better national economy to enrich foreign exchange reserves, provide jobs, and ultimately achieve a better quality of life. Indonesia is a country that makes exports one of the sources of state revenue in both the oil and gas and non-oil and gas sectors.The Indonesian government, represented by several Ministers at the 2020 World Economic Forum (WEF) meeting in Davos, Switzerland, is optimistic that it can boost national industrial exports. This is because there is still a lot of potential that can be developed in Indonesia. The industrial sector has a strategic role in the national economy. This is evidenced cumulatively, the export performance of the non-oil and gas processing industry in the January-December 2022 period amounted to US$ 206.35 billion, an increase of 16.45% over the same period in the previous year.
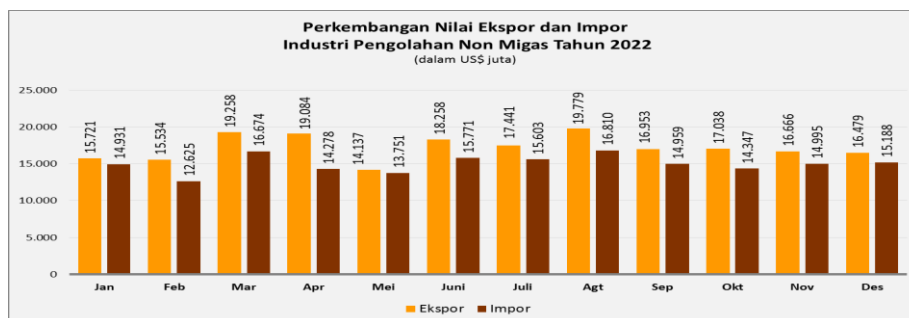
Source: Ministry of Industry (2022)

Figure 1. Development of Non-Oil and Gas Export and Import Value

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The electronics industry is one of the leading sectors. By the government, the sector was included in the Making Indonesia 4.0 program, along with six other priority industrial sectors. In addition to the electronics industry, the food and beverage, textile and apparel, automotive, medical devices, pharmaceutical, and chemical industries are also included in the program. Similar to the other six industrial sectors, electronics is prioritized because it is considered to contribute greatly to national industrial growth, especially from the manufacturing and non- oil and gas groups.

In the classification carried out by the Ministry of Industry, the electronics industry sector is included in the metal goods, machinery, transportation equipment and electronics (ilmate) industry, which contributes greatly to the gross domestic product (GDP) of the non-oil and gas industry. This indicator can be seen from the growth of the ilmate sector, which during the second quarter of 2022 was recorded to contribute 6.65 percent to GDP. This means that the growth of the sector was recorded above national economic growth. The increasing competitiveness of Indonesian electronics products, both in the domestic and global markets, gives confidence for new investors to enter Indonesia and invest. (Hidranto, 2022).

Source: BPS (2022)
Figure 2. Export value of non-oil and gas processing

The electronics industry sector based on the computer, electronic and optical goods sub-sector is included in the top 5 sectors that have a high export value. Citing data from the Central Bureau of Statistics, the value of electronics exports contributed exports of USD4.17 billion in the January-June 2022 period. Meanwhile, the macro portrait, it is undeniable that the ILMATE sector plays an important role in the formation of national GDP. When dissected further, the contribution of each subsector is the basic metal industry subsector which contributes 21.7 percent. Next, the metal goods industry, computers, electronic goods, optics, and electrical equipment (36.1 percent), the machinery and other equipment industry (7.1 percent), and the transportation equipment industry (35.1 percent). From the above description, it must be recognized that the metal, machinery, transportation equipment and electronics (ilmate) industry subsector is one of the leading industries in Indonesia's manufacturing industry sector.

There are several statistical methods that can be used to analyze and assessthe competitiveness of commodity exports in the non-oil and gas sector. Nirmala, 2016 in his research shows the results that Indonesian electronics commodities have comparative competitiveness indicated by an RCA value of more than one and using Porter's Diamond analysis shows that the comparative competitiveness of Indonesian electronics is still weak. Abdi (2019) in his research shows that the marketing strategy carried out by PT Electrolux has an effect and **has competitiveness on increasing sales of air conditioning products.**
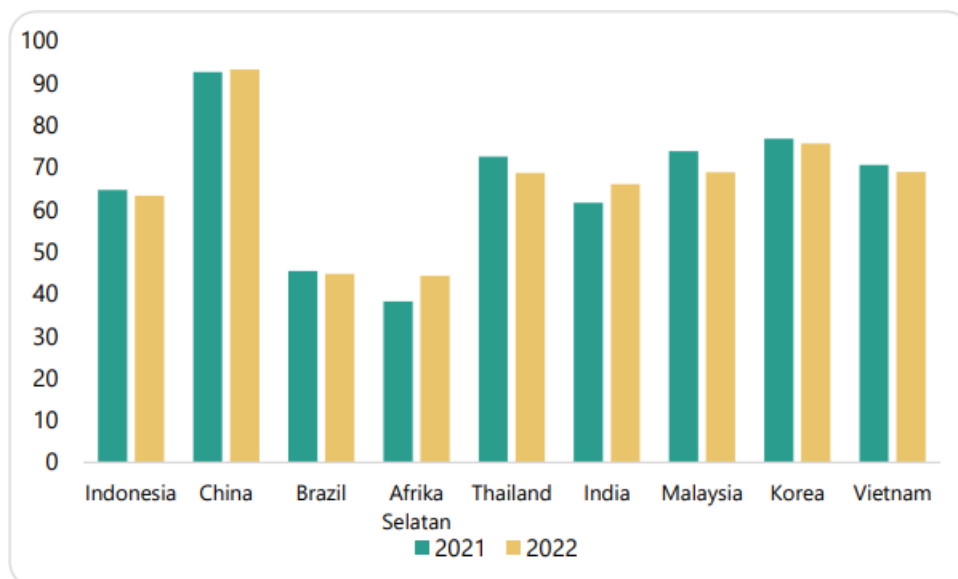
Figure 3. Manufacturing Industry Competitiveness Ranking

Research on electronic commodities has been done before. One of the relevant previous studies on commodity export competitiveness in Indonesia is "Export Competitiveness of Indonesian Manufacturing Industries" by N. Anggraeni, A. Harvie, and C. Kuncoro (2018) in the Bulletin of Indonesian Economic Studies journal. This study analyzes the export competitiveness of the manufacturing industry sector in Indonesia, including the electronics sector, and the factors that influence it. The results show that Indonesia's manufacturing sector as a whole has a fairly weak and underdeveloped export competitiveness compared to other countries in Southeast Asia. Factors such as lack of investment in research and development, poor infrastructure, complex bureaucracy, and policy uncertainty are considered to be the main obstacles to improving Indonesia's export competitiveness.

Research conducted (Sukmawati, 2011) on the analysis of factors affecting the demand for Indonesian pearl exports uses two analyses, namely descriptive and quantitative analysis. Descriptive analysis to describe the condition of the development of Indonesian pearl export demand and quantitative methods are used to analyse the factors that influence Indonesian pearl exports. The data analysis model used in this study is using multiple regression models with the Pooled Least Square (PLS) estimation method. The results showed that at a real level of ten percent the GDP per capita of the importing country, the exchange rate of the importing country, the export price of pearls to the destination country significantly influenced the export demand for Indonesian pearls, while the population of the importing country had no significant effect at a real level of ten percent on the export demand for Indonesian pearls.

Research conducted by (Saptanto, 2017) on the Competitiveness of Indonesian Fishery Product Exports in ASEAN and ASEAN-China Scopes using the Revealed Comparative Advantage (RCA) analysis method. The data used is data from 2000 to 2008. The results of this study indicate that at the ASEAN and ASEAN-China levels, Indonesian products that have competitiveness are products with HS code 03 (fish, shrimp, soft animals, aquatic invertebrates), HS 710110 (unprocessed natural pearls), HS 710121 (unprocessed cultured pearls), and HS 121220 (seaweed and other algae). The results in this study show that Indonesia is still weak in terms of exporting value-added products.

Research conducted by (Hafni, 2011) on Competitiveness Analysis and Factors Affecting the Flow of Indonesian Banana Exports using the Revealed Comparative Advantage (RCA), Export Product Dynamic (EPD), and Intra-Industry Trade (IIT) methods to analyze commodity competitiveness during the 2005-2009 period and the gravity model approach to analyze factors affecting the flow of Indonesian banana exports to destination countries with panel data in the form of time series 2001-2009 and cross section of six export destination countries: Japan, Hong Kong, Singapore, Malaysia, Saudi Arabia, and the United States and using fixed effect analysis.

The research conducted here has several differences with previous studies. The countries studied are the 7 main export destination countries for electronics products based on manufacturing competitiveness rankings. To analyze its competitiveness, RCA analysis is used. This study also uses biplot analysis in measuring the potential map of electronic commodities to improve their competitiveness to be more effective. Based on the background previously described, there is room for further study related to the condition of the competitiveness of the Indonesian computer goods, electronic goods, optical, and electrical equipment industries in several trading partners. In this case, the competitiveness index is measured using the Revealed Comparative Advantage (RCA) index. In addition, biplot analysis was conducted, which is a form of Multiple Variables Analysis (APG) which, among others, can provide a graphical description of the diversity of variables, proximity between objects and the relationship between variables and objects. One of the uses of biplot analysis is to obtain mappings (Greenacre, 2009). Mapping export

potential, for example, can be used to obtain an overview of the closest position. This mapping is expected to provide input in obtaining an overview of the advantages and disadvantages of each country to export. Therefore, biplot analysis can be used to obtain a mapping of potential countries based on the factors that will be involved in this study.

II. METHOD

A. International Trade Theory

International trade occurs when both parties benefit or *gain from trade,* but the most important thing in international trade is that the two countries conduct mutually beneficial trade transactions. International trade provides opportunities to export goods whose production factors are used as abundant resources and import goods whose production factors are scarce or expensive if produced domestically. International trade allows each country to specialize in limited production of certain goods so as to achieve a higher level of efficiency with a larger scale of production (Halwani, 2020). The following are the theories of international trade, among others:

a. Theory of Absolute Advantage

A country is said to have absolute advantage because each country can produce a good at an absolute lower cost than another country. The advantage of absolute advantage is the occurrence of free trade between two countries that have different absolute advantages, where exports and imports increase the prosperity of the country. The downside is that if only one country has an absolute advantage, then international trade will not occur (Mahyus, 2014).

b. Competitive Advantage Theory

There are six (6) categories of attributes that are determinants of the competitive advantage of the national industry. According to this theory, there are four determinants of international competitiveness, namely resource factor conditions, demand conditions, the existence of related and supporting industries, competition, structural conditions, and domestic corporate strategies. As a complement, there are two external variables, namely the role of government and opportunities.

c. Theory of Comparative Advantage

Ricardo (1895) said that a country is predicted to export goods that can be produced by its labor relatively more efficiently and import goods that are relatively less efficient. In other words, a country's production pattern is determined by Comparative Advantage (Krugman et al., 1999), which is more based on real rather than monetary quantities or variables, so it is often known as the *Pure* Theory of International Trade.

According to Tambunan (2004), there are three methods to analyze the competitiveness of a country. The first is the Revealed Comparative Advantage (RCA). This method explains that if a country's exports of a type of goods in which the percentage of the country's total manufacturing exports is higher than the share of world exports, then this country has a comparative advantage over the production and export of these goods.

d. Heckscher-Ohlin (H-O) Theory of Excellence

According to this theory, each country has neo-classical factors of production (land, labor, capital) in a different ratio, while to produce a certain good requires a certain combination of factors of production. However, it does not mean that the combination of factors of production is fixed so that to produce a certain kind of goods, the production function is the same everywhere, but the proportion of each factor can be different (due to the substitution of one factor for another within a certain limit). A country trades with other countries because the country has a comparative advantage, namely excellence in technology and production excellence. The basis of comparative advantage is endowment, which is the ownership of factors of production in a country, factor intensity and technology used in the production process whether labor intensive or capital intensive. In the H-O theory analysis uses two curves, namely, the isocost curve, which is a curve that describes the same total production costs and the isoquant curve, which is a curve that describes the same total product quantity (Hady, 2022).

B. Competitiveness

According to Porter (1990), competitiveness is the level of productivity which is defined as the output produced by a labor force. Meanwhile, according to (T. Tambunan, 2001), basically the level of competitiveness of a country in the international market is determined by two factors. The first factor is the comparative advantage which can be considered as a natural factor and the second is the competitive advantage factor which can be considered as a factor that is acquired or can be developed.

C. Revealed Comparative Advantage (RCA) Theory

One that can show indicators of changes in comparative advantage is the *Revealed Comparative Advantage* (RCA) method, RCA is an index used to measure the relative advantages and disadvantages of certain commodities in a country that are reflected in its trade patterns. This index shows the comparison between the export share of a commodity or a group of commodities of a country against the export share of that commodity from all over the world or in other words the RCA index shows the comparative advantage or export competitiveness of a country in a commodity against the world. This concept was first introduced by Ballasa in 1965, who considered that a country's comparative advantage is reflected or can be seen in its exports.

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Systematically, the RCA Index is as follows:

$$RCA_{ij} = \frac{\frac{X_{ij}}{X_i}}{\frac{X_{iw}}{X_w}}$$

Where :

Xij = Export value of industrial commodities of Computer Goods,Electronic Goods, Optics; and Electrical Equipment from Indonesia to world countries

Xj = Indonesia's total export value to the world

Xiw = Export value of Computer Goods, Electronic Goods, Optical; andElectrical Equipment industry in the world

Xw = Total world export value

If the RCA index value of a country for a particular commodity is greater than one, (RCA index > 1) it means that the country has a comparative advantage above the world average in that commodity. Conversely, if the RCA index value of a country for a particular commodity is smaller than one (RCA index < 1), it means that its comparative advantage for that commodity is low or below the world average (T. Tambunan, 2001). Hinloopen & Van Marrewijk (2001) classified Ballasa index into 4 groups as presented in Table 1.

Table 1. Classification of RCA Values

Group	RCA Value	Competitiveness Strength
A	0<RCA<1	No comparative competitiveness
B	1<RCA<2	weak
C	2<RCA<4	Medium
D	RCA>4	powerful

D. Biplot Analysis

Biplot analysis was first introduced by Gabriel (1971). Biplot is a graphical display by overlaying row vectors representing objects and column vectors representing variables in a low-dimensional space (≤ 3). Information that can be obtained from biplots include:

1. Proximity between objects. Two objects with the same characteristics will be depicted as two points positioned close together which can be seen visually on the biplot Figure of object suitability.
2. Variable diversity. Variables with small diversity are depicted as short vectors, and vice versa, variables with large diversity are depicted as long vectors.

In biplot analysis, variables are depicted as vectors. If the angle of two variables is acute (<900) then the correlation is positive. If the angle of two variables is obtuse (>900) then the correlation is negative. Meanwhile, if the angle of two variables is right-angled, they are not correlated. This information can be used to assess how one variable affects or is affected by another. By using a biplot, the variables will be depicted as directed lines. Two variables that are highly positively correlated will be depicted as two lines with the same direction, or forming a narrow angle. Meanwhile, two variables that have a high negative correlation are depicted as two lines with opposite directions, or form an obtuse angle. Meanwhile, two variables that are not correlated will be depicted as two lines with an angle close to 90° (right angle).

Biplot analysis is developed on the basis of Singular Value Decomposition (DNS) or Singular Value Decomposition (SVD). (Gower et al., 2011) SVD aims to decompose an n x p matrix X, which is a multiple variable matrix corrected for its mean where n is the number of observations and p is the number of variables, into threematrices. Matrix X is a matrix that contains p variables to be studied and n research objects.

$$X = \begin{bmatrix} X_{11} & X_{12} & X_{13} & \ldots & X_{1p} \\ X_{21} & X_{22} & X_{23} & \ldots & X_{2p} \\ \ldots & \ldots & \ldots & \ddots & \vdots \\ X_{n1} & X_{n2} & X_{n3} & & X_{np} \end{bmatrix}$$

A direct approach to get the singular value, with the equation used is an n x p matrix X containing n objects and p variables that have rank r, can be written as

nXp= nUrLrA'p (1)

With :

U = matrix size n x r

L = matrix size r x r

A = p x r matrix size

With U and A being column orthonormal matrices, such that U'U = A'A=Ir . Matrix A is a matrix whose columns consist of eigenvectors ai corresponding to the eigenvalues λi of matrix X'X. Matrix U is the matrix whose columns are the eigenvectors corresponding to the eigenvalues of matrix XX'.

The data used is data on Indonesia's export value *(net weight)* based on commodities and destination countries from 2018 to 2022 using secondary data collection techniques obtained from the Central Statistics Agency (BPS), UNComtrade, and TradeMap with the following research variables:

Y1 : Computer industry

Y2 : Electronic goods

Y3 : Optical goods

Y4: Electrical Equipment

and Indonesia's top 10 export destinations China, USA, Japan, India, Malaysia, Australia,Philipine, Singapore, Vietnam, and Thailand.

III. RESEARCH RESULTS

A. *Overview of the Electronics Industry in Indonesia*

A country is said to have competitiveness if it has comparative advantage and competitive advantage. Ricardo (1895) argued that a country is said to havecomparative competitiveness if it is relatively superior in producing a commodity even though it does not have an absolute advantage in that commodity. So even though a country cannot produce a commodity at a lower cost than other countries, it can still specialize in that commodity. Porter (1990) states that a country is said to have a competitive advantage if the country can market its products relative to other countries.

GDP Growth and Contribution
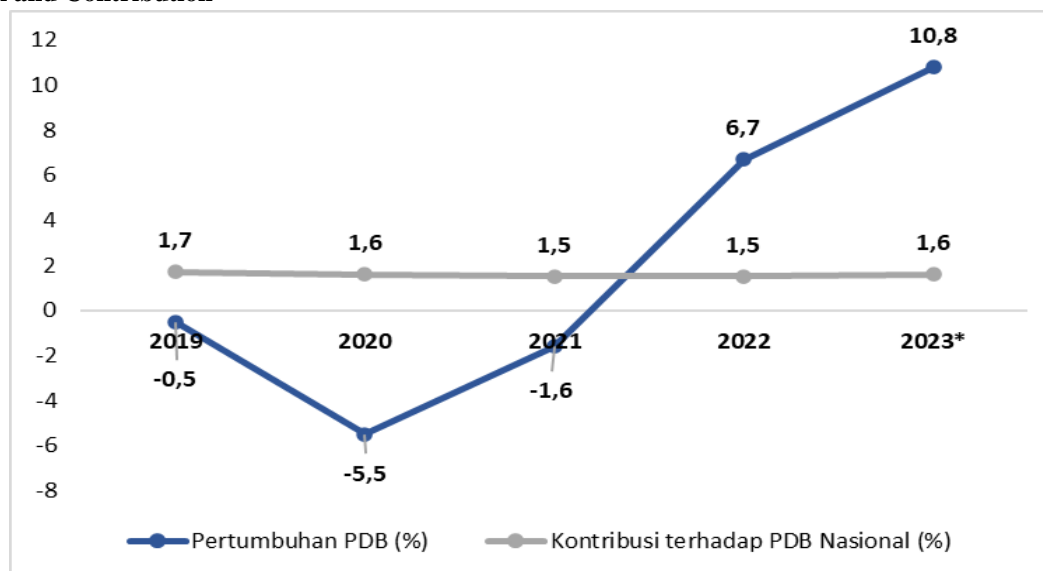
Source: BPS (processed by Pusdatin of the Ministry of Industry) based on 2010 SeriesBusiness Field groupings
*Data *as of June 2023*

Based on the figure above, the GDP value of the Electronics and Telematics Industry Sector (IET) is in group 11, namely the Metal Goods, Computer, Electronic Goods, Optical and Electrical Equipment Industries. In 2020, the IET sector experienced a contraction due to the impact of the ongoing covid-19 pandemic and began to show significant growth in subsequent years. Judging by the contribution of the electronics industry to the National GDP, the IET sector tends to be stable in a span of 5 years.

IET Sector Export-Import (billion USD)

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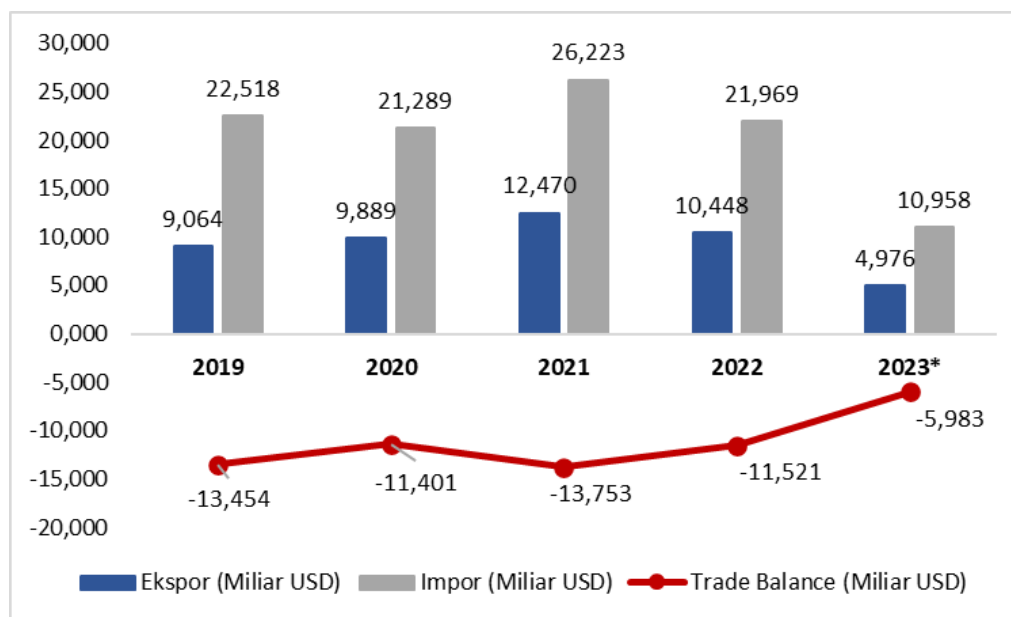
Source: BPS (processed by Pusdatin Ministry of Industry)
* Provisional data as of May 2023

Based on the figure above, it can be seen that the import value of electronics and telematics products is still higher than the export value. It can also be seen that the trade balance of electronics and telematics products from year to year still shows negative numbers, this is because there is still a dominance of imported products, especially for imports of IC components which show an increase in imports in the last 5 years.

B. Competitiveness Analysis of Indonesian Footwear in the International Market

Comparative competitiveness analysis using RCA has been conducted in many studies. The RCA value can show the strength of the comparative competitiveness of a country's commodities in the world and certain export markets. The greater the RCAvalue, the stronger the competitiveness. The results of the calculation of the RCA value ofIndonesia's computer goods, electronic goods, optical and electrical equipment industries against global countries that have the largest export values are presented in Table 2.

Table 2. RCA value of computer, electronic goods, optical and electrical equipment industries electrical equipment industry of Indonesia against Global Countries in 2017-2022

Year	China	Brazil	South Africa	Thailand	India	Malaysia	Vietnam
2017	0,05	1,69	1,05	0,48	0,33	0,14	0,38
2018	0,04	4,98	0,46	0,47	0,31	0,12	0,55
2019	0,04	6,94	0,57	0,51	0,24	0,13	0,45
2020	0,04	7,01	1,28	0,52	0,23	0,12	0,45
2021	0,04	11,36	2,35	0,39	0,22	0,13	0,34
2022	0,03	9,49	2,15	0,31	0,24	0,08	0,31

The table above shows the RCA value of Indonesia's computer, electronic goods, optical and electrical equipment industry against 7 countries with a high level of competitiveness in the global market. The table above shows that Indonesia shows an increasing trend in competitiveness in Brazil and South Africa, especially in 2021 with peak RCA values of 11.36 and 2.35. This means that Indonesia has the opportunity to increase exports of industrial products of computer goods, electronic goods, optics and electrical equipment to these 2 countries . When compared to 5 other countries, it can be seen that Indonesia's RCA value against 5 other countries has a value <1, which meansthat Indonesia does not yet have comparative competitiveness in China, Thailand, India, Malaysia and Vietnam. This is thought to be due to Indonesia's relatively lagging technological development compared to other ASEAN countries, thus limiting Indonesia's ability to diversify its products towards more technology-driven industries (Wie, 2006). In line with these estimates, the Making Indonesia 4.0 program must continue to make strengthening efforts to increase awareness of technological changes in order to continue to compete in the global market and increase its competitiveness.

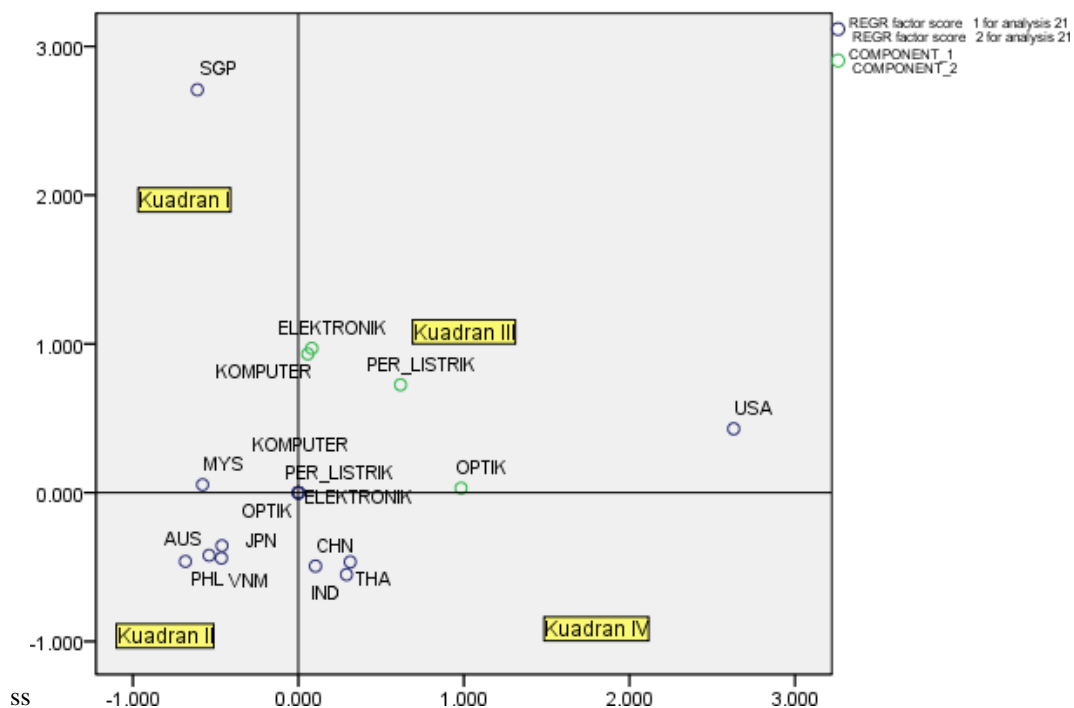### C. Export Potential Map Analysis of Electronics Industry

Figure 4. Biplot Graph

Based on the biplot graph above, there is closeness between variables, namely between 10 export destination countries and the electronics industry sub-sectors, namely computer goods, electronic goods, optical goods and electrical equipment. From these results, information can be obtained that the relationship between these variables based on the net weight of each electronics industry sub-sector is divided into 4 quadrants with the following results:

1. Quadrant I :
Singapore and Malaysia have the same characteristics based on the export net weight of the electronics and telematics industry sector. Judging from the distance and angle of the vector formed, it can be seen that Indonesia has the potential to export computer and electronic goods to the following countries

2. Quadrant II : The United States of America (USA) has its own characteristics
3. Quadrant III : Australia, Philippines, Vietnam and Japan have similarcharacteristics
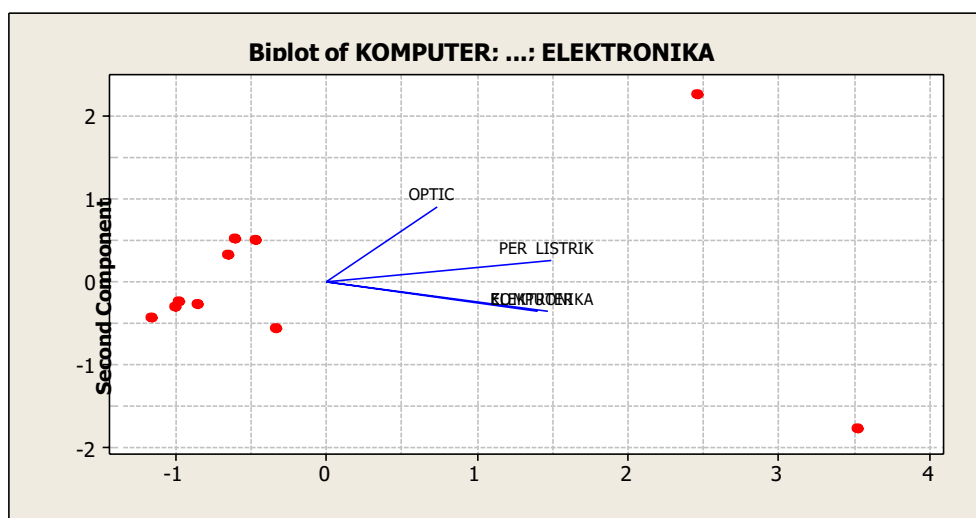4. Quadrant IV : China, India and Thailand have similar characteristics.

Figure 4. Biplot Graph by industry sub-sector

Based on the figure above, by looking at the direction of the vector angle formed, information can be obtained that optical goods and electrical equipment have exportpotential to the United States. This is due to the high FOB value and net weight of the optical goods and electrical equipment sub-sectors to that country. Meanwhile, the electronics and computer sub-sectors have

export potential to Singapore, this can also be explained by the high *netweight* and FOB values for the electronics and computer goods sub-sectors to Singapore.

IV.   CONCLUSIONS

Based on the results of the analysis that has been carried out, the following conclusions can be obtained:

1. The electronics and telematics industry sector has high export opportunitiesand potential, based on the contribution of the electronics industry to the national GDP, which tends to be stable in a span of 5 years.
2. Indonesia has high competitiveness in industrial products of computer goods, electronic goods, optics and electrical equipment to South Africa and Brazil based on RCA values greater than 1.
3. Based on biplot analysis, optical goods and electrical equipment have export potential to the United States. Meanwhile, the electronics and computer sub- sector has export potential to Singapore.

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