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THE RELATIONSHIP BETWEEN COMMERCIAL, TECHNOLOGICAL, RESEARCH (MULTIDIMENSIONAL) COMPLEXITY INDICES AND FINANCIAL DEVELOPMENT

Ticari, Teknolojik, Araştırma (Çok Boyutlu) Kompleksite Endekslerinin Finansal Gelişme ile İlişkisi

Tuba Esra BASKAK*

Keywords:
Economic Growth, Financial Economics, Panel Data Models

JEL Codes:
O40, P34, C23

Abstract

The source of economic growth is the supply-demand balance. Demand refers to consumption and supply refers to production. Producing quality products plays an important role on the production side of this balance. The country, which has a wide range of qualified products called sophisticated products, continues to grow with financial development. The concept of economic complexity refers to product diversity. This concept has taken its place in the literature by being expanded into commercial, technological, and research complexity indices as the content of the multidimensional complexity index. In this study, the relationship between multidimensional complexity indices and financial development indicators of E7 (Emerging) countries (Brazil, China, India, Indonesia, Mexico, Russia, Turkey) is analyzed with Gengenbach, Urbain, and Westerlund Cointegration Test and Mean Group Estimator applied in case of cointegration. It has been determined that these variables are cointegrated, and this relationship between the commercial and technological complexity index and financial development is significant. As a result of the analysis with the mean group estimator, it was concluded that the technological complexity index has a greater impact on financial development than the commercial and research complexity indices.

Anahtar Kelimeler:
Ekonomik Büyüme, Finansal Ekonomi, Panel Veri Modelleri

JEL Kodları:
O40, P34, C23

Öz

Ekonomik büyümenin kaynağı arz-talep dengesidir. Talep tüketimi, arz ise üretimi ifade eder. Bu dengenin üretim tarafında kaliteli ürün üretmek önemli rol oynuyor. Sofistike ürünler olarak adlandırılan geniş bir nitelikli ürün yelpazesine sahip olan ülke, finansal gelişmeyle birlikte büyümeye devam ediyor. Ekonomik karmaşıklık kavramı ürün çeşitliliğini ifade etmektedir. Bu kavram, çok boyutlu karmaşıklık indeksinin içeriği olarak ticari, teknolojik ve araştırma karmaşıklığı indeksleri olarak genişletilerek literatürdeki yerini almıştır. Bu çalışmada E7 (Gelişmekte olan) ülkelerin (Brezilya, Çin, Hindistan, Endonezya, Meksika, Rusya, Türkiye) çok boyutlu karmaşıklık endeksleri ile finansal gelişmişlik göstergeleri arasındaki ilişki Gengenbach, Urbain ve Westerlund Eşbütünleşme Testi ve eşbütünleşme bulunması durumunda uygulanan Ortalama Grup Tahmincisi ile analiz edilmiştir. Bu değişkenlerin eşbütünleşik olduğu ve ticari ve teknolojik karmaşıklık endeksi ile finansal gelişme arasındaki bu ilişkinin anlamlı olduğu tespit edilmiştir. Ortalama grup tahmincisi ile yapılan analiz sonucunda teknolojik kompleksite endeksi finansal gelişmede üzerinde ticari ve araştırma kompleksite endekslerinden ziyade daha büyük etkiye sahip olduğu sonucuna varılmıştır.

* Dr., Independent Researcher, Türkiye, tuba.baskak@cbu.edu.tr

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1. Introduction

Economic growth is among the most important goals of every country. There are variables representing more than one macro indicator that mutually affects economic growth. It is a fact that macroeconomic indicators are used more in the literature. Macroeconomic variables are important for both countries and studies. In addition to these variables, new indicators have also emerged in the literature. Economic complexity and multidimensional economic complexity (trade, technological, and research complexity indices) are some of the new indicators.

The difference and quantity of products are considered rather than how many countries produce products. The diversity of products reveals the concept of complexity. Instead of producing more than one product of the same product, a country produces sophisticated products and sells them in the national and international markets, which contributes positively to the country's economy. The concept of complexity is measured by the economic complexity index. In the last year, this concept has taken its place in the literature under the name of multidimensional complexity index, including commercial, technological, and research complexity index. A country's product diversity depends on technological development, exports and imports, research and development expenditures, innovation, active use of knowledge, inclusion of skills, financial opportunities provided to economic decision-making units, and financial development.

When looking at the literature, it is noteworthy that studies mostly focus on economic complexity and growth variables for analysis. There are also analyses in the literature that include financial development. However, it has been divided into three different indices and started to be published on the website of The Observatory of Economic Complexity, affiliated with the Massachusetts Institute of Technology, since 2023. A study analyzing the commercial complexity index, technological complexity index, and research complexity index, which is called the multidimensional complexity index, has not been found in the literature. This study's contribution to the literature occurs here.

Following the introduction section, information about financial development and the multidimensional complexity index is given, and the analysis is started. In the study, the relationship between financial development and multidimensional complexity indices of E7 Countries (Brazil, China, India, Indonesia, Mexico, Russia, Türkiye), which are fast growing and have great importance in global trade, was analyzed. A model was established in which the dependent variable is financial development, and the independent variable is multidimensional complexity indices. There are 23 years and 7 units in the analysis, which covers the period between 1999 and 2021. The time dimension is larger than the unit dimension. For this reason, the Pesaran CD cross-sectional dependency test was used. Then, the Swamy S homogeneity test was used to determine homogeneity. Gengenbach, Urbain, and Westerlund’s Cointegration Test were conducted for cointegration between variables, and the significance of cointegration was estimated with the Weighted Group (MG) Estimator. In the conclusion section, the findings were interpreted, and suggestions were made.

2. Theoretical Frame and Literature Review

2.1. Theoretical Frame

The structural changes contribute to the growth of the country's economy. When a country focuses on the characteristics it has, increases its product diversity, and stands out from other countries in this diversity, it realizes structural changes. It is important for countries to use their characteristics in areas with high productivity. This situation reveals the concept of economic complexity. Economic complexity means using a country's output in productive areas and supporting it with knowledge and skills (Erkan and Yildirimci, 2015).

The concept of economic complexity emerged inspired by the products exported by countries. The diversity of products exported by a country reflects the concept of complexity, and the fact that exports increase the country's income reflects the concept of economic growth. Rather than whether a country produces more than one product and exports these products, it is more important which countries produce a product. The same product produced in two different countries differs depending on the country's knowledge and skills. The quality of the products is more important than the number of products produced in the country (Rodrik, 2006).

The knowledge and skills of countries show the quality of the products they produce and the products they will export in the future. For example, learning a foreign language is something that an individual can do by spreading his knowledge over time. If a football player has the ability to score goals, it means that he will be a good football player. This ability shows the skill of the football player (Can and Dogan, 2018). Countries should also attach importance to knowledge as well as skill in product production. The fact that countries have a very high level of skills and knowledge causes them to produce many products in qualitative and quantitative terms, and these products differ from other products (Hausmann and Hidalgo, 2011).

If the income level in a country is different, the skill level and active use of information in that country are not developed. Since countries with low levels produce fewer and unqualified products, they either cannot sell these products at all or very little. However, countries with high levels can produce more sophisticated products. The export of sophisticated products is high, and income levels are increasing rapidly (Hausmann and Hidalgo, 2010).

The development of countries in terms of knowledge and skills depends on the economic decision-making units in the country. The country's knowledge and skill levels are also improving with the combination of individuals' desire to learn, companies' desire to develop, and the support provided by the state to households and companies. The support of companies and the state is important in this regard (Can and Dogan, 2018).

Financial development is the transfer of capital from inefficient areas to productive areas with the support of technology. The development of the country's banking sector also leads to financial development. As the opportunities provided to companies and individuals in the banking sector increase, the number of products produced in the country also increases. Local producers, who easily obtain capital, increase their sophisticated products. Companies with increased capital are developing technologically as they enable easier purchase of machinery, tools, and equipment. Technologically developing companies' production speeds are increasing, and they are starting to produce more sophisticated products. The support of individuals and companies by banks and politicians causes the products produced and exported in the country to

increase both qualitatively and quantitatively. The quantitative and qualitative increase in products also increases the country's trade, technological structure and research, including its R&D structure. Commercial, technological and research complexity indices, which are three important distinctions of economic complexity, are also increasing. The increase in these three complexity indices, called multidimensional complexity indices, has an impact on the income levels of countries and the country's economy grows (Shahbaz et al., 2013). Financial development affects multidimensional complexity indices by increasing exports through capital, technology and banking channels. Likewise, a positive indicator in the indices means that the country's economy is moving in a positive direction, which means that exports, banking sector, technology and capital are improving. These situations also have a positive impact on financial development. In the form of a theoretical hypothesis, an increase in financial development increases multidimensional complexity indices. Increasing index values also increase financial development. Theoretically, a mutual positive effect is expected.

It has been seen as a deficiency in the literature that the concept of economic complexity is insufficient to measure its impact, especially on sustainable green growth, and that this measurement is made only through the trade indicator. Upon the request to evaluate this measurement in terms of innovation indicators, the concept of economic complexity started to be published with commercial, technological, and research data called multidimensional complexity indices (Stojkoski et al., 2023).

After the 1980s, with the adoption of Neoliberal Economic Policies, economic growth and foreign trade began to accelerate positively. The financial opportunities provided after the policies implemented have an impact on the increase in economic growth and the prevention of foreign trade deficit. Financial development is also the result of economic growth. Economic growth and financial development both affect and are affected by each other. This is the reason why financial development has not experienced much change since the 1980s. As seen in Figure 1, financial development in E7 countries remained within a certain band. However, Brazil has made very good progress in financial development after 2010.

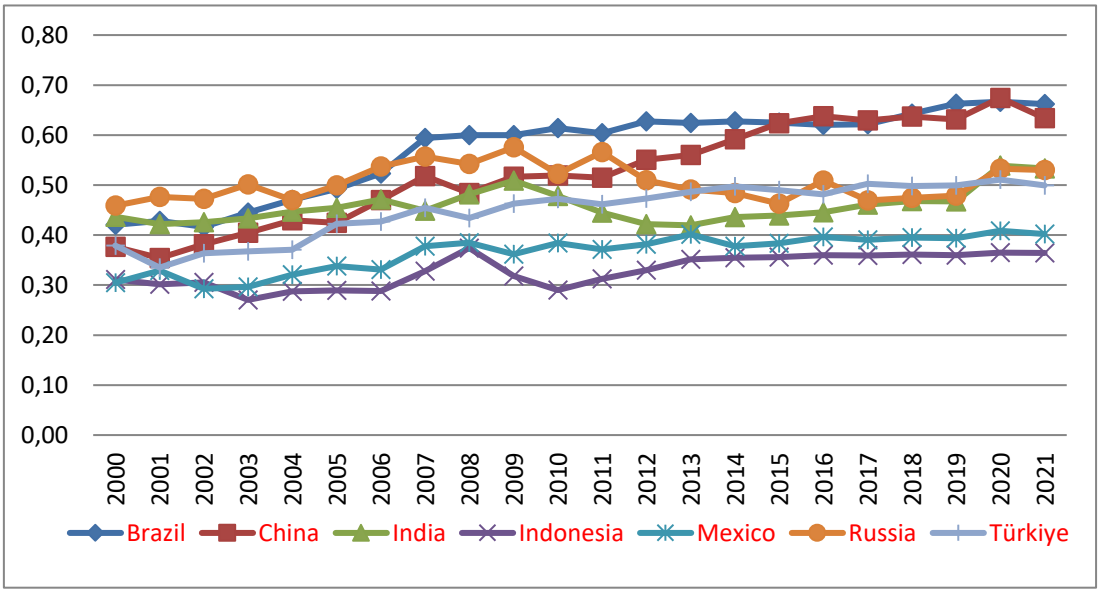

Figure 1. Financial Development of E7 Countries
Source: International Monetary Fund, 2024.

Figure 2 shows that India, which is among the E7 countries, increased its trade and the diversity of commercial products with a rapid acceleration between 2002 and 2003. However, there was a sudden decline between 2003 and 2004. Trade was also negatively affected as India slowed down in economic growth in the early 2000s. After 2005, E7 countries have generally experienced an increase in the diversity of commercial products. India came to the forefront in terms of exports and imports in 2021. As seen in Figure 2, its maximum commercial level is in 2021. Among these countries, Indonesia has the lowest trade complexity index. It can be said that the very high population of Indonesia compared to other countries causes domestic production to be consumed and exports to decrease.

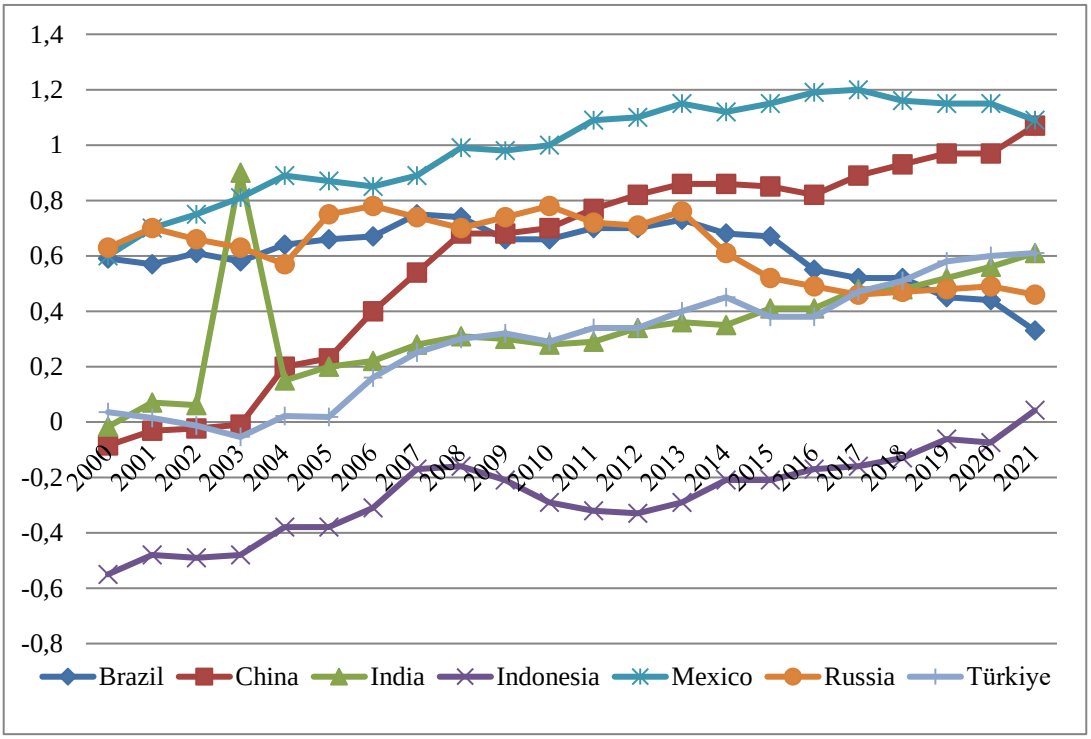

Figure 2. Trade Complexity Indexes of E7 Countries
Source: The Obsarvatory of Economic Complexity, 2024.

Mexico and China generally appear to have and export an increasing level of product diversity. However, the fact that China is at very good levels in e-commerce and foreign trade, especially in 2021, is also reflected in the figure. Türkiye has followed a general trend and even increased in recent years. However, the reason for the decrease after a certain increase in Russia can be attributed to the existence of regional income inequality despite being in a good position in terms of foreign trade. Political inactivity in fast-growing Brazil and protests within the country have hindered its development. The fact that Brazil is the largest coffee producer and has sophisticated products besides coffee has increased the commercial complexity index. However, like Russia, trade in Brazil has declined in recent years.

As seen in Figure 3, E7 countries have not been able to gain regular technological momentum. In Mexico and Indonesia, overpopulation and economic inequality lead to a situation where technological development and the production of sophisticated products based on technology are put on the back burner. Russia, Brazil and Türkiye have followed the same

path. Since India is the fastest growing economy after 2010, it has made technological progress in the years after 2010. In recent years, China has declined technologically and risen commercially. It is considered that this is due to decline and rise.

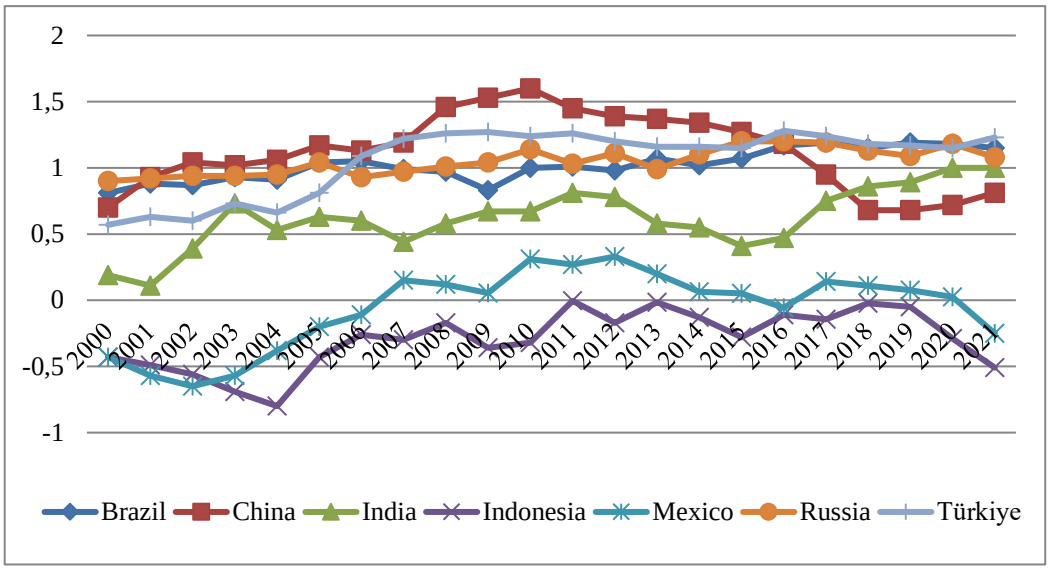

Figure 3. Technology Complexity Indexes of E7 Countries
Source: The Obsarvatory of Economic Complexity, 2024.

Looking at Figure 4, E7 countries increased their research-based sophisticated products between 2005 and 2017 but decreased in the remaining years. Since E7 Countries are among the fast-growing countries with a high share in global trade, they have given more importance to the production of trade and technology-oriented products. It is thought that the crises caused the decline in research and development activities in the 2000s. Countries that have experienced a decline in recent years have started to rise again in terms of innovation, research, and information technologies.

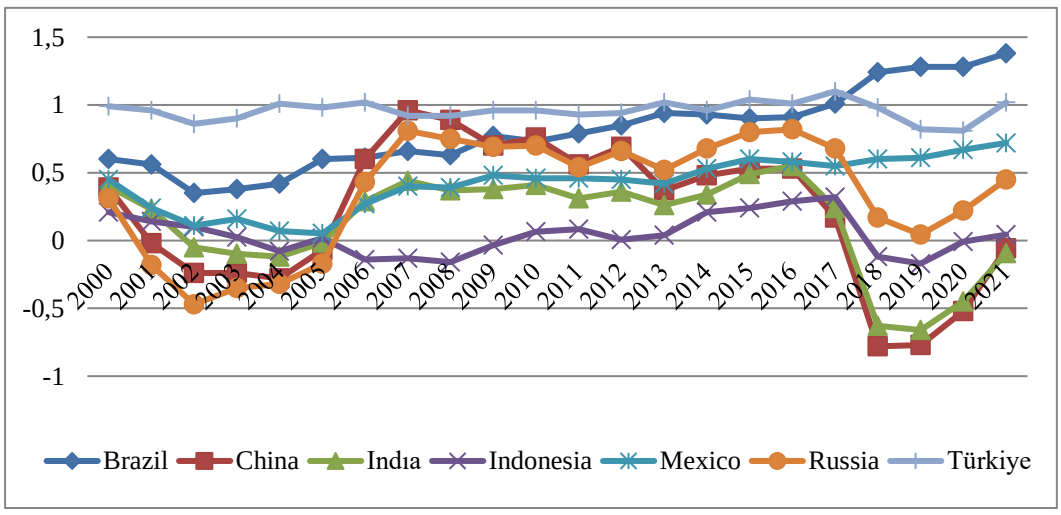

Figure 4. Research Complexity Indexes of E7 Countries
Source: The Obsarvatory of Economic Complexity, 2024.

2.2. Literature Review

Looking at the literature, the relationship of the economic complexity index with multiple variables has been analyzed. However, no study analyzing the commercial complexity index, technological complexity index and research complexity index, which is called the multidimensional complexity index, has been found in the literature. However, it is useful to analyze financial development and economic complexity.

Daude et al. (2015) analyzed the financial development and economic complexity index data of 103 countries between 1976 and 2010. It was found that financial development is a variable that determines economic complexity. Can and Dogan (2018) conducted a cointegration test in their study covering the years 1970 and 2013. It was seen that financial development positively affected economic complexity and the relationship between them was significant. Nguyen et al. (2020) analyzed financial development and economic complexity variables of 52 countries between 1995 and 2017. It has been determined that financial development affects the other variable positively in the short term. However, this effect is negative in the long term. Sahin and Durmus (2020) examined the relationship of the economic complexity index with capital investments, patent applications, and foreign direct capital investments, as well as the financial development variable. Newly industrializing countries were used in the research. Variables were found to be significant in Türkiye and Mexico. Another consequence is that financial development causes complexity.

Nguyen and Su (2021) analyzed the financial development and economic complexity variables of 86 countries covering the years 2002 and 2017. It has been determined that financial development has a positive impact on economic complexity. Njangang et al. (2021) examined the impact of financial development on economic complexity in 24 African countries between 1983 and 2017. In these countries, the relationship between financial development and economic complexity was positive. Efeoglu (2022) tested the relationship between financial development and complexity in N11 countries in his study covering the years 1995-2019. It has been concluded that increasing financial development also increases economic complexity. Kazemzadeh et al. (2023) conducted PVAR analysis in their study covering 49 countries. Financial development and economic complexity variables were also evaluated in the analysis. The variables that are positively related in the first period are found to be negatively effective in the third lag.

Can and Doğan (2018), Nguyen and Su (2021), Njangang et al. (2021), Efeoglu (2022) found that two variables positively affect each other. However, Nguyen et al. (2020) found a positive relationship only in the short term. They detected a negative relationship in the long term. Şahin and Durmuş (2020) concluded that there is a significant relationship between them, especially in Türkiye and Mexico. In the same studies, it was found that financial development affects complexity.

3. Data, Method and Results

3.1. Data

Using panel data analysis in data based on studies spanning time and countries is important for the accuracy of the results. Since there are 23 years and 7 countries, panel data analysis was performed. In the study where Brazil, China, India, Indonesia, Mexico, Russia and

Türkiye, known as E7 Countries, were discussed, the relationship between commercial, technology and research complexity indices, known as multidimensional complexity index, and financial development between 1999 and 2021 was examined.

For convenience in the study, the variables used are given abbreviated names. As shown in Table 1, FD represents financial development, TRADE represents business complexity index, TECHNOLOGY represents technology complexity index, and RESEARCH represents research complexity index.

Table 1. The Details of Variables

Variable Name	Description	Source
FD	Financial Development	International Monetary Fund (2024)
TRADE	Trade Complexity Index	Obsarvatory of Economic Complexity (2024)
TECHNOLOGY	Technology complexity Index	Obsarvatory of Economic Complexity (2024)
RESEARCH	Research complexity Index	Obsarvatory of Economic Complexity (2024)

In the model where financial development and commercial, technological and research complexity indices are examined, commercial, technological and research complexity indices are considered as independent variables. The established model is as follows;

$$FD = \beta_0 + \beta_1 TRADE + \beta_2 TECHNOLOGY + \beta_3 RESEARCH + \mu_{it} \quad (1)$$

FD in the model in equation 1 is the dependent variable defining financial development. Variables with β coefficients on the right side of the equation represent independent variables, and μit indicates the error term. Multidimensional complexity indices were taken from The Obsarvatory of Economic Complexity website, and financial development was taken from the International Monetary Fund website. In this study, the Stata program was used to perform the analysis. The purpose of building the model is to determine the relationship between the selected variables and to express the order in which they were selected in the stata program. At the same time, another purpose of specifying this model is to show that the relationship between the dependent variable of financial development and multidimensional complexity indices is analyzed. The relationship between the independent variables has not been determined.

As a result of the study by Stojkoski et al. (2023), the concept of economic complexity index started to be expressed as multidimensional complexity index. Their study proved that the multidimensional complexity index, which consists of commercial, technological and research complexity indices, has a great impact on the income distribution of countries (Stojkoski et al., 2023). The last purpose of the model is to show that the financial deepening relationship has been analyzed in addition to this study.

3.2. Method

When looking at the probability values of the tests, a significance level of 0.05 is taken into account. Comments are made at this level. If the resulting value is less than the 0.05 significance level, it will reject the null hypothesis, and if it is greater than it, it will be accepted. If it is greater, the null hypothesis of the test is accepted. The probability values resulting from all tests performed in this study were interpreted according to the 0.05 significance level.

In panel analysis, horizontal cross-section and homogeneity should be checked. Analysis should start with these tests first. Because, according to the results of these tests, it is decided which unit root test, cointegration test and causality test will be used. For this reason, Pesaran CD cross-sectional dependence test and Swamy S homogeneity test were used in this study.

The proposition of the null hypothesis is expressed as there is no cross-section, and the proposition of the alternative hypothesis is expressed as there is. In the homogeneity test, the null hypothesis includes the proposition that the model is homogeneous, and the alternative hypothesis includes the proposition that the model is heterogeneous (Swamy, 1970; Ozayturk and Alper, 2017).

The analysis continues with unit root tests. If the model turns out to be heterogeneous and there is cross-sectional dependence in the model, a unit root test from the 2nd group of second generation unit root tests should be preferred. Horizontal Section Extended Im, Pesaran and Shin Unit Root Test is one of this group of tests. The null hypothesis of this test indicates the absence of stationarity, and the alternative hypothesis indicates stationarity (Yerdelen Tatoglu, 2018). If the series do not turn out to be stationary, their differences should be taken. The differenced series become stationary.

Gengenbach, Urbain and Westerlund Panel Cointegration Test and Mean Group Estimator are used to look at cointegration between variables and test their significance. The null hypothesis of the cointegration test is the absence of cointegration, and the alternative hypothesis is the existence of cointegration. As a result of this test, the significance of the cointegrated variables is checked. For this purpose, cointegration estimator is made. This estimator shows the impact of variables on each other and the significance relationship between variables. The null hypothesis of the cointegration estimator includes the proposition that the long-term relationship is meaningless, and the alternative hypothesis is significant (Gengenbach et al., 2016).

3.3. Results

As seen in Table 2, the values are below 0.05. The test revealed the existence of cross-sectional dependence in the model.

Table 2. Pesaran CD Cross Section Dependency Test

Variables	Statistical Value	Probability Value
FD	13.49	0.0000
TRADE	5.27	0.0000
TECHNOLOGY	11.57	0.0000
RESEARCH	6.28	0.0000

Table 3 shows that the probability values are less than the 0.05 significance level. The null hypothesis containing the homogeneous proposition of the Swamy S test was rejected. It was concluded that the model was heterogeneous.

Table 3. Swamy S Homogeneity Test

Chi-Square Value	Statistical Value	Probability Value
Chi (24)	739.13	0.0000

As a result of the unit root test, it was found that the variables were not stationary. This situation can be seen in Table 4. After retesting the variables by taking their first differences, it was revealed that the variables became stationary at their first difference, as the probability values were less than 0.05 significance level. The letter D is added to the names of the variables to indicate that their first differences are taken.

Table 4. Cross Section Extended Im, Pesaran and Shin Unit Root Test

	I(0)			I(1)	
Variables	Statistical Value	Probability Value	Variables	Statistical Value	Probability Value
FD	-1.479	0.070	DFD	-6.220	0.000
TRADE	0.474	0.682	DTRADE	-3.002	0.001
TECHNOLOGY	-0.370	0.356	DTECHNOLOGY	-3.026	0.001
RESEARCH	1.946	0.974	DRESEARCH	-3885	0.000

In Table 5, the cointegration test's probability value is = 0.01, which reveals a cointegration relationship between the variables subject to analysis.

Table 5. Gengenbach, Urbain and Westerlund Cointegration Test

Variables	Coefficient	Statistical Value	Probability Value
FD - TRADE	-0.730	-3.232	<=0.01
FD - TECHNOLOGY	-0.775	-3.309	<=0.01
FD - RESEARCH	-0.728	-3.281	<=0.01

The results of the model estimated with the cointegration estimator in terms of financial development trade complexity index are shown in Table 6. Looking at the general coefficients, when the trade complexity index is increased by 1%, financial development increases by approximately 13%. According to the probability value, the long-term relationship between financial development and the trade complexity index is significant. The long-term relationship was insignificant in Brazil and India but significant in other countries. In Brazil, when the trade complexity index is increased by 1%, financial development decreases by approximately 0.13%.

Table 6. Mean Group Forecaster (FD-TRADE)

General Coefficients		
Coefficient	**Statistical Value**	**Probability Value**
0.1251	2.51	0.012
Unit-Specific Coefficients		
	Brazil	
Coefficient	Statistical Value	Probability Value
-0.1331	-0.72	0.472
	China	
Coefficient	Statistical Value	Probability Value
0.2285	12.01	0.000
	India	
Coefficient	Statistical Value	Probability Value
0.0582	1.90	0.057
	Indonesia	
Coefficient	Statistical Value	Probability Value
0.1402	5.29	0.000
	Mexico	
Coefficient	Statistical Value	Probability Value
0.1890	10.62	0.000
	Russia	
Coefficient	Statistical Value	Probability Value
0.1319	2.01	0.044
	Türkiye	
Coefficient	Statistical Value	Probability Value
0.2609	11.28	0.0000

When the general coefficients in Table 7 are examined, it has been determined that when the technology complexity index is increased by 1%, financial development increases by approximately 15%, and according to the probability value result, it has been determined that the dependent variable and the technological complexity index affect each other in the long term. When unit-specific coefficients are examined, it is seen that the cointegration relationship between the variables is significant in countries other than China and Russia. In China, when the technological complexity index is increased by 1%, financial development decreases by approximately 0.005%.

Table 7. Mean Group Forecaster (FD-TECHNOLOGY)

General Coefficients		
Coefficient	**Statistical Value**	**Probability Value**
0.1481	2.09	0.037
Unit-Specific Coefficients		
	Brazil	
Coefficient	Statistical Value	Probability Value
0.5549	5.60	0.000
	China	
Coefficient	Statistical Value	Probability Value
-0.0005	-0.01	0.994
	India	
Coefficient	Statistical Value	Probability Value
0.0584	3.13	0.002
	Indonesia	
Coefficient	Statistical Value	Probability Value
0.0935	3.85	0.000
	Mexico	
Coefficient	Statistical Value	Probability Value
0.1110	5.97	0.000
	Russia	
Coefficient	Statistical Value	Probability Value
0.0432	0.55	0.584
	Türkiye	
Coefficient	Statistical Value	Probability Value
0.1762	9.92	0.000

The dependent variable and research complexity index results of the estimator are shown in Table 8. Looking at the general coefficients, when the research complexity index is increased by 1%, financial development increases by approximately 7%, and according to the probability value result, It is seen that the dependent variable and the research complexity index are insignificant in cointegration. According to the units, cointegration is significant in Brazil and Mexico, but insignificant in the rest. In China and India, when the research complexity index is increased by 1%, financial development decreases by approximately 0.02% and 0.03%, respectively.

Table 8. Mean Group (MG) Forecaster (FD-RESEARCH)

General Coefficients		
Coefficient	**Statistical Value**	**Probability Value**
0.0753	1.87	0.062
Unit-Specific Coefficients		
	Brazil	
Coefficient	Statistical Value	Probability Value
0.2546	6.61	0.000
	China	
Coefficient	Statistical Value	Probability Value
-0.0258	-0.61	0.542
	India	
Coefficient	Statistical Value	Probability Value
-0.0336	-1.74	0.082
	Indonesia	
Coefficient	Statistical Value	Probability Value
0.0187	0.38	0.702
	Mexico	
Coefficient	Statistical Value	Probability Value
0.1573	4.69	0.000
	Russia	
Coefficient	Statistical Value	Probability Value
0.0327	1.77	0.076
	Türkiye	
Coefficient	Statistical Value	Probability Value
0.1237	0.64	0.519

4. Conclusion and Suggestions

This study analyzed the relationship between financial development and commercial, technological, and research complexity indices, called multidimensional complexity indices, of the developing E7 countries, which have a high share in global trade and are fast growing. Since panel data analysis was performed, cross-sectional dependency and whether the model was heterogeneous were examined first.

Pesaran CD cross-section dependence test was used to analyze cross-section dependence, and Swamy S homogeneity test was used to determine homogeneity. There is cross-sectional dependence, and the model was found to be heterogeneous. In cases where there is cross-sectional dependence, and the model is heterogeneous, one of the second generation second group unit root tests was chosen to determine the stationarity of the series. Horizontal Section Extended Im, Pesaran, and Shin Unit Root Test showed that the series became stationary after taking their first differences. Then, Gengenbach, Urbain, and Westerlund Cointegration Test was applied to detect cointegration. The variables were found to be cointegrated. After this test, which showed that the effects of the variables used in the analysis would continue in the long term, the model was estimated with the Mean Group Estimator to look at the significance levels.

No analysis using the multidimensional complexity index has been found in the literature. This situation has led to a focus on analyses made with economic complexity. Can and Doğan (2018), Nguyen and Su (2021), and Efeoglu (2022) reach the following conclusion: These two variables have a positive impact. Similar results emerged in this study. However, Nguyen et al. (2020) found positivity between the two variables in the short term. Negativity has been detected in the long term. This finding differs from the analysis conducted in this study.

Because the significance of the long-term relationship was determined in the study. Similarly, as a result of the study conducted by Şahin and Durmuş (2020), it was seen that the data for Türkiye and Mexico were meaningful. It was similar to the results of this study.

As a result, it was found that the change in the technological complexity index affected financial development more, followed by commercial and research complexity indices. While financial development is greater in countries where the economy is at a good level, there is also financial development in countries where economic growth is overflowing. Theoretically, since commercial, technological and research arguments have a positive effect on economic growth and this effect is significant, the positive and significant effect resulting from the analysis supports the theory.

The fact that domestic and foreign sales of sophisticated products provided by technological development are more effective in financial development shows that the technological momentum achieved by Brazil, China, India, Russia, and Türkiye in the E7 countries is in the right direction. However, Indonesia and Mexico need to attach importance to technological progress in terms of growth, foreign trade, and increasing product diversity.

Since there is no literature on the multidimensional complexity index, it is evaluated in the context of the economic complexity index. For this reason, the evaluation of this study, which is thought to contribute to the literature, in the context of the literature is limited. However, in general, the positive impact of the studies on economic complexity on growth and financial development is a theoretically expected result. Moreover, the majority of this study's mean group estimator results are also consistent with the theory. The theoretical hypothesis is that the multidimensional complexity index increases as financial development increases. This hypothesis is also valid in the reverse case. The majority of the results of the analysis also support this hypothesis. The negative effect of Brazil on the commercial complexity index, China on the technology complexity index, and China and India on the research complexity index is an indication that financial development is not in good condition in these countries. Because this is not the theoretically expected result. These countries need to follow policies towards financial development.

In contrast to the theoretical framework, the analysis reveals a negative and insignificant relationship between China's technological complexity index and financial sophistication. This suggests that the country has progressed more slowly in terms of technology due to its shift towards foreign trade and progress in e-commerce. Therefore, China's policymakers are advised to emphasize technological and trade progress. The effect of the trade complexity index on financial development is close to that of the technological complexity index. The trade complexity index is significant and positive in the E7 countries except Brazil and India due to the bad condition of Brazil's trade. While Brazil has made significant strides in technological advancement and innovation, commercial product diversity production remains in the background. For this reason, it is recommended that Brazil's policymakers pursue policies that increase foreign trade. When the research complexity index is examined from a theoretical perspective, it is seen to be less effective than the commercial and technological complexity index. The analysis result was the same as the theoretical result. However, since E7 countries are in the middle-income country group, In order to avoid being caught in the middle-income trap, which is a problem in the growth of the economy, and to get rid of this problem, research and development studies must accelerate.

They need to improve their knowledge and skills not only in commercial and technological development but also in research. The fact that the research complexity index was significant and positive only in Brazil and Mexico also supports theoretical information. Because, unlike other countries, the research complexity indices of these two countries have progressed in an increasing trend.

As a result, it is recommended that policy makers in E7 countries prepare policies that provide opportunities to support financial development in achieving innovation, technological progress and sustainable growth targets in the context of multidimensional complexity indices.

Declaration of Research and Publication Ethics
This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement
I am a single author of this paper. My contribution is 100%.

Declaration of Researcher's Conflict of Interest
There is no potential conflicts of interest in this study.

References

Can, M. and Dogan, B. (2018). The relationship between economic complexity and financial development: An empirical analysis in the Turkish sample. *Finance, Political and Economic Comments*, 638, 5-16. Retrieved from https://dergipark.org.tr/tr/pub/fpeyd/

Daude, C., Nagengas, A. and Perea, J.R. (2015). Productive capabilities: An empirical analysis of their drives. *The Journal of International Trade & Economic Development*, 25(4), 504-535. https://doi.org/10.1080/09638199.2015.1073342

Efeoglu, R. (2022). Economic complexity and financial development in N11 countries. *Manisa Celal Bayar University Journal of Social Sciences*, 20(1), 185-196. https://doi.org/10.18026/cbayarsos.1016597

Erkan, B. and Yildirimci, E. (2015). Economic complexity and export competitiveness: The case of Türkiye. *Procedia-Social and Behavioral Sciences*, 195, 524-533. https://doi.org/10.1016/j.sbspro.2015.06.262

Gengenbach, C., Urbain, J-P. and Westerlund, J. (2016). Error correction testing in panels with common stochastic trends. *Journal of Applied Econometrics*, 31(6), 982-1004. https://doi.org/10.1002/jae.2475

Hausmann, R. and Hidalgo, C.A. (2010). *Country diversification, product ubiquity, and economic divergence* (Harvard Kennedy School Faculty Research Working Paper No. 201). Retrieved from https://dash.harvard.edu/bitstream/handle/1/4554740/RWP10-045_Hausmann_Hidalgo.pdf

Hausmann, R. and Hidalgo, C.A. (2011). The network structure of economic output. *Journal of Economic Growth*, 16(4), 309-342. https://doi.org/10.1007/s10887-011-9071-4

International Monetary Fund. (2024). *Financial development* [Dataset]. Retrieved from https://www.imf.org/en/Data

Kazemzadeh, E., Fuinhas, J.A., Koengkan, M. and Shadmehri, M.T.A. (2023). Relationship between the share of renewable electricity consumption, economic complexity, financial development and oil prices: A two-step club convergence and PVAR model approach. *International Economics*, 173, 260-275. https://doi.org/10.1016/j.inteco.2022.12.001

Nguyen, C.P. and Su, T.D. (2021). Financing the economy: The multidimensional influences of financial development on economic complexity. *Journal of International Development*, 141, 644-684. https://doi.org/10.1002/jid.3541

Nguyen, C.P., Schinckus, C. and Su, T.D. (2020). The drivers of economic complexity: International evidence from financial development and patents. *International Economics*, 164, 140–150. https://doi.org/10.1016/j.inteco.2020.09.004

Njangang, H., Asongu, S., Tadadjeu, S. and Nounamo, Y. (2021). *Is financial development shaping or shaking economic sophistication in African countries?* (European Xtramile Centre of African Studies WP. No. 21/018). http://dx.doi.org/10.2139/ssrn.3806772

The Obsarvatory of Economic Complexity. (2024). *Multidimensional complexity indices* [Dataset]. Retrieved from https://oec.world/en

Ozayturk, G. and Alper, A.E. (2017). The effect of oil imports on the current account deficit: An analysis of OECD countries. *Ankara University SBF Magazine*, 72(3), 513-524. https://doi.org/10.1501/SBFder_0000002457

Rodrik, D. (2006). What's so special about China's exports? *China & World Economy*, 14(5), 1-19. https://doi.org/10.1111/j.1749-124X.2006.00038.x

Sahin, D. and Durmus, S. (2020). Determinants of the level of economic complexity in newly industrializing countries. *ODU Journal of Social Sciences Research*, 10(2), 334-351. Retrieved from https://dergipark.org.tr/tr/pub/odusobiad/

Stojkoski, V., Koch, P. and Hidalgo, C.A. (2023). Multidimensional economic complexity and inclusive green growth. *Communications Earth & Envıronment*, 4, 130. https://doi.org/10.1038/s43247-023-00770-0

Swamy, P.A.V.B. (1970). Efficient inference in a random coefficient regression model. *Econometrica*, 38(2), 311. https://doi.org/10.2307/1913012

Yerdelen Tatoglu, F. (2018). *Panel time series analysis stata applied* (2. Ed.). Istanbul: Beta Publications.