THE RELATIONSHIP BETWEEN ECONOMIC COMPLEXITY AND ECONOMIC GROWTH: A PANEL VAR APPROACH FOR OECD COUNTRIES

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ABSTRACT

Economic complexity presents a new perspective in describing and explaining the state of the economy of countries. It measures the complexity and status of a country's products and income levels. The higher the economic complexity index, the higher the rate of growth, the faster the development of countries and the more productive activities emerge. Based on these presuppositions, this study examines the relationship between economic complexity and economic growth for OECD countries using panel data analysis, namely a panel VAR model and a causality test. It covers the period of 2000-2021. Based on the obtained results the relationship between economic complexity and growth was found to be positive but statistically insignificant, whereas the causality test suggests a uni-directional causality, meaning that economic complexity does not cause economic growth, whereas economic growth causes economic complexity.

KEYWORDS:
ECONOMIC COMPLEXITY, ECONOMIC GROWTH, PANEL VAR, OECD

JEL CLASSIFICATION CODES:
C23, O47, O57

1. INTRODUCTION

Nowadays technology and innovation stand at the roots of economic growth of countries. They are also important factors for the increase of economic complexity index. For this reason, it has always been emphasized that developing and underdeveloped countries need a change and transformation compared to developed countries. The main problem is that the growth figures do not always go in a uniform order, and there is a large difference among countries. Thus, emphasis should be placed on increasing technology and innovation in order to achieve high economic welfare. As a result of the development of higher technology products and the increase in innovation, sustainable economic growth will be achieved.

In terms of growth, economic complexity has revealed a new approach, it is prepared based on the products exported by the countries. Economic complexity is a criterion that simultaneously reveals the prevalence and diversity of exported products in terms of the skills and quality of the countries. Today, for example, Luxembourg is about 11 times richer than Mexico, and Norway is about 107 times richer than Uganda. In terms of goods and services as a percentage of GDP, Singapore exports 17 times more than Pakistan, and Luxembourg 5 times more than Mexico. Therefore, this study aims to examine the relationship between economic complexity and economic growth using panel data analysis for OECD countries. Thus, the purpose of this study is to verify whether a causal relationship exists between Economic Complexity and GDP per capita growth for this set of countries. Economic complexity indicates that countries ought to accumulate productive knowledge to improve their standards of living. Hausmann et.al (2011) claimed that the differences in the levels of income are because of variances of productive knowledge between states, and the reason behind these differences rests behindhand the diversity of production structures.

2. LITERATURE REVIEW

The studies on the direct relationship between economic complexity and economic growth are very limited. However, recently the literature on economic complexity has been expanded with studies that consider not only economic growth but also other factors such as financial development and income inequality.

Among the most prominent studies is that of Hidalgo (2009) who evaluated the 42-year process in his research on the dynamics of economic complexity and product space. According to the inference obtained, Brazil, Indonesia, Turkiye, Malaysia, Thailand, Korea, Singapore, and China are defined as the countries where productive structures have changed. Among this group, it was emphasized that while Korea, Singapore, and China progressed to the top in the ranking of economic complexity, Brazil, Indonesia, and Turkiye started from a less complex basis, although they made changes in their productive structures.

Abdon et al. (2010) and Felipe et al. (2012) used the concepts of economic complexity and product complexity to examine the relationship between economic development and product complexity by considering 5104 products and 124 countries. According to the inference made, it was determined that the most complex products were machinery, chemicals, and metals, while the least complex products were raw materials and commodities, wood, textiles, and agricultural products. It is stated in the study that more complex products are exported by rich countries, while less complex products are exported by poorer countries. The most complex economies in the world are Japan, Germany, and Sweden. The least complex economies are Cambodia, Papua New Guinea, and Nigeria. In addition, it is stated that the export shares of different complex products vary according to per capita income. Export shares of the most complex products increase with revenue, while export shares of less complex products decrease with revenues. The sensitivity of export shares to per capita income increases as the complexity level of the product is higher than the average complexity level.

Tacchella et al. (2012) developed a new map-based approach to capabilities and product complexity. It is stated that this approach is a simple method to measure the competitiveness of countries. According to the inferences, it is stated that the only condition for a product to have a high-quality level is that it is produced only by countries with high competitive power. It is also stated that countries that specialize in a limited number of products exported by many countries remain poor.

Ferrarini and Scaramozzino (2013) investigated the effect of complexity in production on output level and growth rate. In the research, it is stated that the intensity of vertical trade between countries is also effective in explaining output performance. The view that production complexity is an important factor was supported to explain the differences in the economic performance of countries. The increased complexity of the endogenous growth model for human capital may have an uncertain effect on the level of output. However, it is predicted that the increase in human capital formation will always have a positive effect on the growth rate. In addition, the average intensity of a country's product area is a measure of the adaptability of that country's production structure across sectors, and this is related to the increase in resource equipment and available technology.

Tacchella et al. (2013) emphasized the importance of product diversification and non-monetary systems for the effective complex structure of products in their research on the relationship between economic complexity and global competitiveness. In terms of the competitiveness of the productive systems of the countries, a new method for the complexity of the products is discussed. According to the findings, it is stated that the application of this method to real country-product matrices can provide important and new information about economic systems and competition between countries, on the other hand, it can be used as a tool for fundamental analysis of financial markets.

Hartmann et al. (2016) examined the relationship between economic complexity levels and income inequality in the countries included in the study by using regression analysis in their study for the period 1996-2001 and 2002-2008. According to the results obtained, it was determined that there was a negative relationship between the economic complexity index and income inequality, and it was emphasized that the increase in economic complexity reduced income inequality.

Can (2016) investigated the relationship between economic complexity and economic globalization in South Korea with data from the 1970-2012 period. The cointegration method and the fully modified least squares method were applied to the analysis. As a result, it has been determined that economic globalization has a positive effect on economic complexity.

Çeştepe and Çağlar (2016) investigated the relationship between product sophistication and economic growth using the panel regression analysis method. In the study, the data from 86 countries were taken into consideration and evaluations were made in six five-year subgroups for the 1982-2012 period. According to the research, it has been determined that the economic complexity index positively affects the growth in per capita income. In countries with a nominal income of less than US$ 20,395 per capita, the rise in the value of economic complexity also leads to an increase in the growth rate. This effect gradually diminishes as the incomes of these countries increase.

Gala et al. (2016) investigated which countries would increase their income and which would remain poor, showing whether levels of economic complexity for rich and poor countries explain the convergence and divergence between countries. According to the research, the complex structure of production and export is important to explain the convergence and divergence between countries. According to the findings, when the export structures of developing countries are similar, there is a convergence between countries in terms of income. In countries that are weak in complexity, the situation is reversed. According to the conclusion, the higher the complexity of the export structure of developing countries in general, the higher the probability that the income of these countries will converge with those of high-income countries.

Stojkoski and Kocarev (2017) investigated the relationship between economic complexity and growth with cointegration and error correction mechanisms. According to the results obtained, economic complexity is a statistically determinant variable of growth in the long run. But in the short run, productive knowledge has not been found to have any effect on income changes in Southeast and Central Europe.

Ivanova et al. (2017) calculated the economic complexity index, patent complexity index, and triple helix complexity measure for 34 OECD member countries and BRICS countries and developing Argentina, Hong Kong, Indonesia, Malaysia, Romania, and Singapore using data from 2000-2014. In the evaluation, it was determined that these three complexity indicators were related to each other, but there was no correlation between them and GDP per capita. In addition, it is seen that Japan got the highest score among all three indicators.

Albeaik et al. (2017) developed the economic complexity index and created a new economic complexity index (ECI+) that measures the total exports of the economy. In the study, economic growth was estimated for 5, 10, and 20-year panels by using panel data analysis with 1973-2013 period data. On average, one standard deviation increase in ECI+ has an impact on annual growth of about 4% and 5%.(Albeaik et al., 2017)

Hartmann et al. (2017) examined the relationship between economic complexity and income inequality by sector by creating a product-level estimator of expected income inequality for countries that export a particular product. In their study on economic complexity and income inequality using the regression analysis with the 1963-2008 period data, they stated that there is a strong relationship between the economic complexity index and income inequality.

Zhu and Li (2017) investigated the effects of economic complexity and human capital on growth for 210 countries using panel data analysis. It has been observed that countries have different levels of complexity and high-income economies have higher levels of economic complexity than low- and middle-income countries. It has been determined that the complex structure and different levels of human capital have positive effects on long- and short-term growth. Between economic complexity and human capital, there is a positive effect on economic growth. In addition, the magnitude of the effect of the interaction between economic complexity and human capital on long- and short-run growth increases as the comparative advantage threshold gets larger.

Can and Doğan (2018), on the other hand, examined the relationship between economic complexity and financial development in the sample of Turkiye with the data for the period 1970-2013. Cointegration and dynamic least squares methods were used in the research. In the findings, it was concluded that financial development affects economic complexity positively.

Brito et al. (2018) in their research on economic complexity, the value of the national currency, corporate investments, and the level of competition in international markets, revealed that the reaction of investments to real exchange rate movements varies depending on the production structure of the economy. According to the Mundell-Fleming model, companies in advanced economies and Asia increase investment when the local currency weakens. When looking at developing economies and some developed countries with low economic complexity, institutional investment increases when the local currency strengthens. According to this result, a stronger real exchange rate reduces investment costs for domestic firms in economies where capital goods are imported the most.

Soyyiğit (2018) examined the relationship between economic complexity and per capita income in OECD founding countries. In the study, the data for the period 1990-2016 were handled and the panel cointegration method was used. According to the inference, no statistically significant relationship was found between the variables for the overall panel. However, in terms of units, it has been determined that there is a positive relationship for Austria, Canada, Greece, Ireland, and the USA, and a negative relationship for Norway.

Jinn and Shuhalmen (2018) examined the economic complexity structure of Malaysia in the historical process. In addition, in the study, they evaluated the growth rates of countries with a similar structure to Malaysia. On the other hand, Ferraz et al. (2018) investigated how efficiently Latin American and Asian countries measured the country's performance in transforming economic complexity into human development between 2010 and 2014. According to the results, it was concluded that all Asian countries except China and the Philippines were productive in 2014. This result confirms that countries with more complex structures create more productive human development.

Kılıç and Balan (2019) examined the relationship between economic complexity and economic growth using the panel ARDL method for 24 selected OECD countries. As the time dimension, the period covering the years 1990-2017 was considered. According to the findings, economic complexity has a positive effect on economic growth in the long run. In the causality analysis, it is deduced that there is a causality from economic complexity to economic growth.

Karadaş and Soyyiğit (2019), in their study on the relationship between the middle-income trap and the level of economic complexity, made an evaluation for Turkiye, Malaysia, and Thailand with 1990-2017 data using the stagnation analysis. According to the results obtained, no convergence was found among high-income countries in the economic complexity index of Turkiye and Thailand. It has been found that Malaysia's economic complexity index converges towards high-income countries. According to these results, the countries closest to overcoming the middle-income trap were Turkiye, Malaysia, and Thailand is Malaysia.

Yıldız G. and Yıldız B. (2019) examined the relationship between economic complexity and economic growth with panel bootstrap Granger causality analysis. In the study, data for the period 1970-2016 were used by taking the economies of China, India, Thailand, Malaysia, Philippines, Turkiye, South Africa, Brazil, Mexico, and Indonesia as a country group. As a result of the application, it has been determined that Mexico, Malaysia, and South Africa have a unidirectional causality relationship from economic complexity to economic growth, while China has a bidirectional causality relationship. In addition, it was found that there is a one-way causality relationship from economic complexity to economic growth for the entire panel.

Britto et al. (2019) discussed the Brazilian and Korean economies for the relationship between economic complexity and development with the data for the period of 1960-2010. In the study, a structural development index was used to measure economic development in countries. It was concluded that although both countries had GDP per capita levels close to each other in the early 1960s, the Korean economy grew faster than Brazil thanks to its early specialization in more complex and technology-intensive areas.

Şahin and Durmuş (2020) examined the relationship between the variables on economic complexity, financial development, capital investments, foreign direct investment, and patent application, for China, Brazil, Mexico, Argentina, India, Thailand, Malaysia, Philippines, Turkiye, and South Africa. Panel data analysis was used with the 1990-2017 period data. As a result of the examination, it was concluded that there is a cross-section dependence in the variables used and in the overall model, but there is no long-term relationship between the variables. In addition, it has been observed that there is a causal relationship between foreign direct investment to the economic complexity index in China and Mexico, domestic patent applications to the economic complexity index in the Philippines, and financial development to the economic complexity index in Turkiye and Mexico. It is concluded that there is no causality relationship between gross capital investments and the economic complexity index.

Rojas and Correa (2021) examined 86 countries with different levels of development with the 1971-2014 period data. According to the result, pollution levels decrease only in developed countries when ECI increases. In another study by Rojas, et al., (2021), the production volume was differentiated by including the economic complexity value to validate the Environmental Kuznets Curve Hypothesis for Colombia. Whether there is a long-term relationship between the variables covering the 1971-2014 period was evaluated by the vector error correction model and regression method. According to the result, it has been seen that the Environmental Kuznets Curve Hypothesis is not valid for the Colombian economy.

Ngarava (2021) analyzed the relationship between economic complexity and carbon dioxide emissions in South Africa with the 1993-2020 period data. According to the results obtained by applying ARDL and the error correction method, while a causality relationship was determined from the carbon dioxide emission variable to the economic complexity variable in the short run, a causal relationship could not be found in the long run.

Philipp (2021) discussed the relationship between economic complexity and growth by evaluating the concept of value-added exports. Theoretically, the effect of export content on growth has been analyzed. In terms of value-added exports, the USA ranks first, while Japan and China follow the USA in terms of economic complexity, respectively. Therefore, when the concept of value-added exports is included in the growth model, the model's explanatory power also increases.

3. RESEARCH METHODOLOGY

The research methodology of this paper consists of panel regression analysis, namely on the panel VAR model and a causality test between growth and economic complexity. Initially is presented the methodology of panel regression analysis using panel VAR and the used data in the empirical analysis. In fact, data sets that combine time series and cross sections (countries) are called longitudinal or panel data sets.

Panel data sets are more orientated towards cross-section analyses- they are wide but typically short (in terms of observations over time). Heterogeneity across countries is central to the issue of analyzing panel data. However, to deal with independent economies is to build panel VAR models. The variables in the VAR model are considered endogenous variables and interdependent, both in dynamic and static wisdom, although identifying restrictions based on theoretical models or on statistical procedures may be imposed to separate the impact of exogenous shocks onto to system (Abrigo et al. 2016). Panel VAR model has been introduced by Holtz-Eakin, Newey, and Rosen (1988) and it is applied to numerous fields by many authors.

In this research paper, the panel VAR model is also used to estimate the dynamic effects of the economic complexity index (ECI) on economic growth. Afterward, a causality test is performed. The estimation and inference of panel VAR is done in the framework of the generalized method of moment (GMM). Panel VAR analysis is predicated upon choosing the optimal lag order in both panel VAR specification and moment condition. The following panel VAR model is used in the empirical analysis:

$$\Delta \Upsilon_{it} = \Phi_0 + \Phi(L)\Delta \Upsilon_{it} + \mathrm{X}_{it}\Psi + u_i + \varepsilon_{it} \quad (1)$$

Where i represents each country i.e. the cross sectional dimension; t represents the time dimension; $\Delta \Upsilon_{\mathrm{it}}$ is the vector of dependent variables; X_{it} a vector of control variables; L is the lag operator; Φ, Ψ represents the matrices of parameters; u_i is a vector of dependent variable-specific panel fixed-effects; ε_{it} in the idiosyncratic error term.

3.1. The Data

In this empirical research annual data from 2000 to 2021 for 37 OECD countries[1] are used. The GDP growth per capita data are provided from World Development Indicator (WDI) database of World Bank, whereas the data of economic complexity index (ECI) are provided from the Observatory of Economic Complexity (OEC). The summary statistic of the variables used in the empirical research are presented in Table 1. Over the period of analysis, the average of GDP per capita growth of OECD countries was 2.06 percent, whereas the average of economic complexity index was 1.04. However, these averages exhibit large discrepancies between OECD countries.

Table 1. Descriptive Statistics

Variable		**Mean**	**Std. Dev.**	**Min**	**Max**	**Observations**
GDPC	overall	2.061237	4.745372	-14.3	23.2	N = 814
	between		2.07083	0.095454	11.80455	n = 37
	within		4.282998	-17.03422	81.25669	T = 22
ECI	overall	1.043838	0.620970	-0.4	2.62	N = 814
	between		0.599973	-0.1509	2.1395	n = 37
	within		0.187596	-1.04616	1.54429	T = 22

Source: Author's calculation

[1] Luxemburg is not included in the sample due to unavailability of data on economic complexity index

Before producing the panel VAR model, an analysis of panel data stationarity is conducted. For this purpose, the Levin-Lin-Chu and Harris-Tzavalis unit-root tests were used. According to the obtained results, the used variables are non-stationary and integrated of order 1, and do contain a unit root as the null hypothesis that panels contain unit root cannot be rejected at 0,05 level of significance (see table 2). The first difference shows a stationary position for both variables, thus for the panel VAR model will be used the stationary version of panel data using the first difference.

Table 2. Unit Root Test

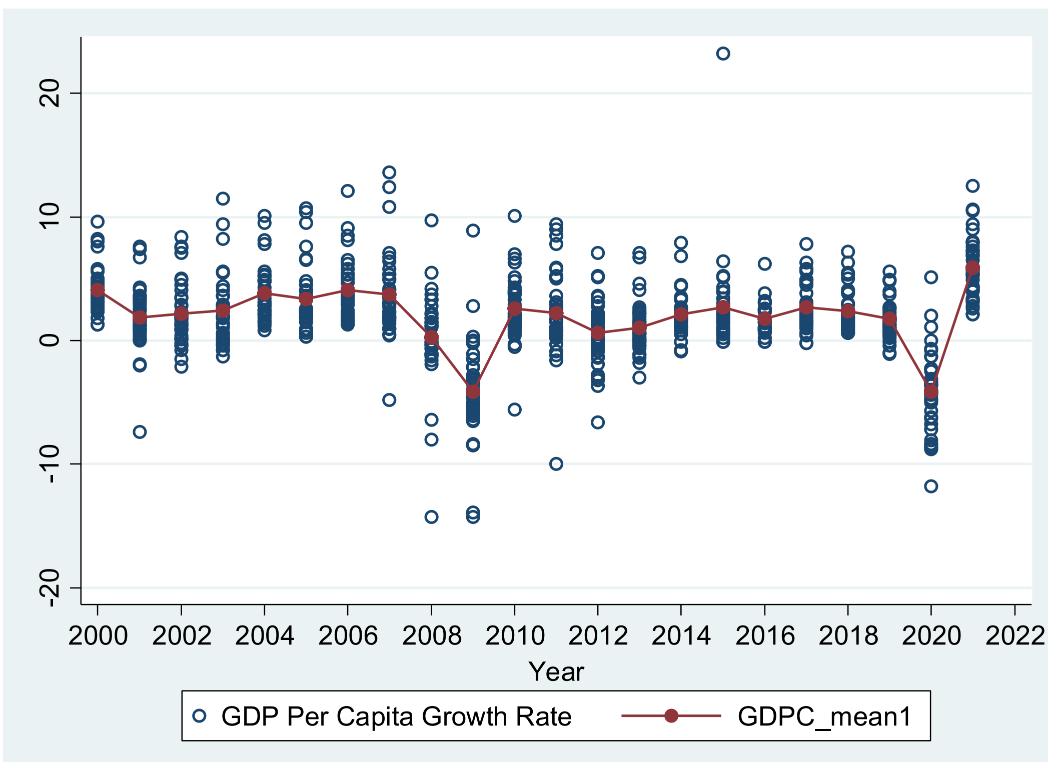
Variable	**Test**	**Level**		**First Difference**	
		Statistics	p-value	Statistics	p-value
GDP per capita growth	Levin-Lin-Chu	0.4724	0.6817	-7.3430	0.000
ECI	Levin-Lin-Chu	-1.2112	0.0942	-11.0970	0.000
GDP per capita growth	Harris-Tzavalis	-2.0154	0.0721	-27.2049	0.000
ECI	Harris-Tzavalis	0.8416	0.1075	-38.9066	0.000

Source: Author's calculation

4. EMPIRICAL RESULTS

According to the average the GDP per capita growth of the countries of OECD (see Figure 1 below) for the period 2000-2021 it can be seen that the average growth rate in 2009 year was negative almost in all countries due to the global financial crisis, while in 2020 as a result of the Covid-19 pandemic the most of countries fall again in recession.

Figure 1. Average of GDP per capita growth over years of OECD Countries



Source: Author's calculation

After fitting the reduced-form panel VAR, an attempt is made to investigate whether past values of the economic complexity index are useful in predicting the values of the economic growth of OECD countries or whether there is Granger causality among economic complexity and economic growth. This is implemented as separate Wald tests with the null hypothesis that the coefficients on all the lags of an endogenous variable are jointly equal to zero. Table 3 below displays the results of selection order statistics to identify the optimal moments and model lag order. The lag orders for the moment instruments and calculated CD as well as MMSC are presented to identify if the model is overidentified. In the table are presented results from the first, second, third, and fourth-order panel VAR models using four lags of the endogenous variables as instruments. For the fourth order only the CD is computed as the model is just identified. Based on the three model selection criteria, the first order has the smallest MBIC, MAIC, and MQIC, meaning that this is the most suitable, however, the second and third order models can be also used as for the three orders the Hansen's J statistic is minimized. The third-order panel VAR model does not reject Hansen's overidentification restriction at the 1% alpha significance level, so the third-order panel VAR model will be used.

Table 3. Selection Order Criteria

lag	CD	J	J pvalue	MBIC	MAIC	MQIC
1	0.5640198	7.535445	0.8202995	-68.73785	-16.46455	-36.85054
2	0.5942616	6.679726	0.5715486	-44.16914	-9.320274	-22.91093
3	0.6225196	4.656687	0.3243705	-20.76774	-3.343313	-10.13864
4	0.3277399	.	.	.	.	.

Source: Author's calculation

Based on the selection order criteria we fit the third-order panel VAR model using four lags of endogenous variables as instruments. The results are displayed in Table 4.

Table 4. Panel VAR Model

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
GDPC						
GDPC						
L1.	-.4671362	.1152975	-4.05	0.000	-.6931152	-.2411571
L2.	-.3439755	.0885288	-3.89	0.000	-.5174888	-.1704621
L3.	-.1997473	.0844448	-2.37	0.018	-.3652562	-.0342385
ECI						
L1.	.4895494	6.049504	0.08	0.936	-11.36726	12.34636
L2.	.5848056	7.444247	0.08	0.937	-14.00565	5.17526
L3.	-6.576111	14.69547	-0.45	0.655	-35.3787	22.22648
ECI						
GDPC						
L1.	.0013835	.0005009	2.76	0.006	.0004018	.0023653
L2.	.0005872	.0006272	0.94	0.349	-.0006421	.0018165
L3.	.0001887	.000504	0.37	0.708	-.0007992	.0011766
ECI						
L1.	-.039125	.0683818	-0.57	0.567	-.1731508	.0949008
L2.	-.037211	.0671849	-0.55	0.580	-.168891	.0944691
L3.	-.080013	.0743079	-1.08	0.282	-.225654	.0656271

Source: Author's calculation

The results of VAR model suggest that the economic complexity index (ECI) does not significantly affect economic growth, whereas economic growth positively affects and is statistically significant at 1% level. These results can be also confirmed by the causality test, where the first result shows whether the coefficients on the three lags of ECI appearing on the GDP per capita growth (GDPC) equation are jointly zero. The null hypothesis that ECI does not granger cause growth is not rejected, however the hypothesis that growth does not granger cause ECI is rejected at 5% significance level. The second test labeled ALL is with respect to the coefficients of all lags of all endogenous variables other than those of the dependent variable being jointly zero. Because we have two endogenous variables in the panel VAR model, this test is the same as the first test (Table 5).

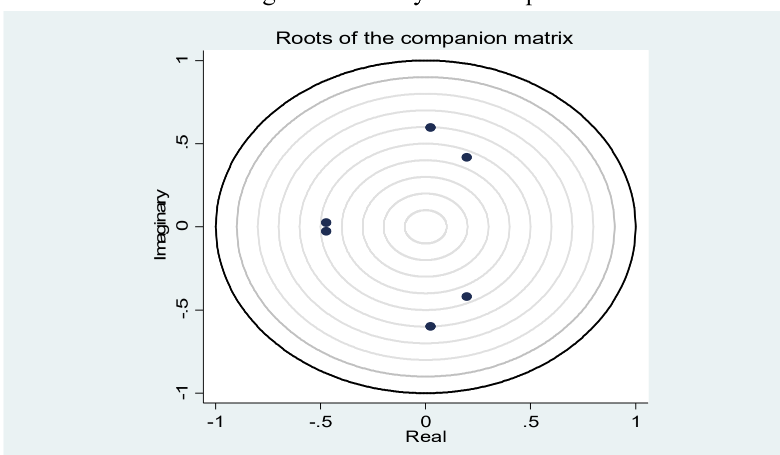
Table 5. Granger Causality Test

Equation \ Excluded		chi2	df	Prob > chi2
GDPC				
	ECI	0.309	3	0.958
	ALL	0.309	3	0.958
ECI				
	GDPC	8.214	3	0.042
	ALL	8.214	3	0.042

Source: Author's calculation

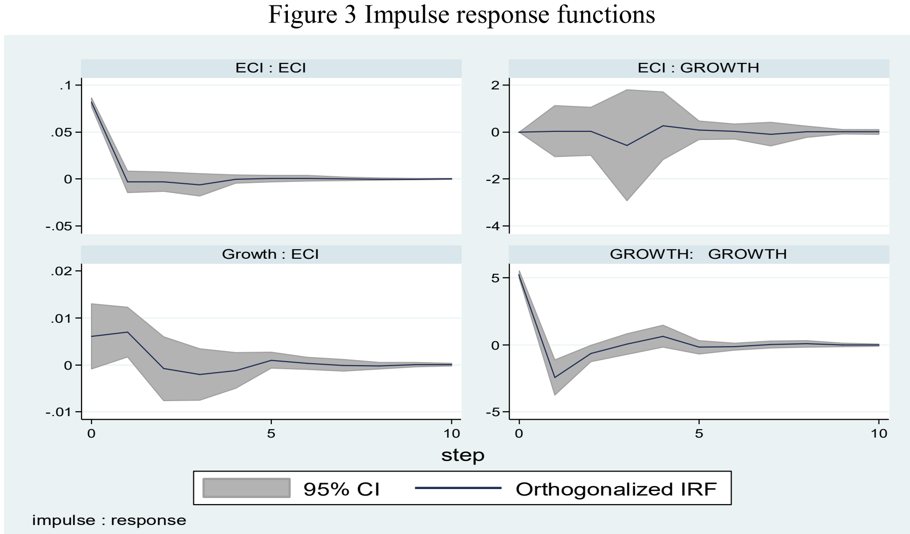
The fitted VAR model is stable based on the stability test because the moduli of the companion matrix based on the estimated parameters suggest it as all the moduli are smaller than one. A graph of the stability test is displayed below in Figure 2. We can observe that the model is stable because the roots of the companion matrix are all inside the unit circle. When the model is stable the assumptions about the error covariance matrix may be imposed and we can compute the impulse response functions and the forecast-error variance decomposition (FEVDs). Orthogonalized impulse responses and variance decompositions may change according to the order of endogenous variables in the Cholesky decomposition.

Figure 2 Stability Test Graph



Source: Author's calculations

Figure 3 Impulse response functions



Source: Author's calculations

The impulse response functions suggest that the economic complexity index does not have a significant effect on economic growth as the confidence intervals include the zero line in the first period, turn negative in the second period and the rest of the periods include also the zero line. Whereas economic growth has a nonlinear impact on the economic complexity index, meaning that in the first period, it is positive, while in the second period, it turns moderately negative and then again positive, however, the last period also includes the zero line (see Figure 3). The impulse response functions' confidence intervals are computed using 200 Monte Carlo runs from the distribution of the fitted panel VAR model.

Table 6 below displays the forecast error variance decompositions, where it can be seen the impulse variables and responses and forecast horizon for 10 periods.

Table 6. Forecast-error Variance Decomposition

Response variable and Forecast horizon	**Impulse variable**	
GDPC	**GDPC**	**ECI**
0	0	0
1	1	0
2	0.9999515	0.0000485
3	0.9999295	0.0000705
4	0.9904005	0.0095996
5	0.988499	0.011501
6	0 .988319	0.0116811
7	0.9883057	0.0116943
8	0.9880665	0.0119335
9	0.9880622	0.0119378
10	0.9880557	0.0119443
ECI	**GDPC**	**ECI**
0	0	0
1	0.0055372	0.9944628
2	0.0126525	0.9873475
3	0.0127311	0.9872689
4	0.013271	0.986729
5	0.0134792	0.9865208
6	0.0136165	0.9863836
7	0.0136286	0.9863714
8	0.0136307	0.9863693
9	0.0136357	0.9863642
10	0.0136364	0.9863636

FEVD standard errors and confidence intervals based on 200 Monte Carlo simulations are saved in file fevd_ci.dta
Source: Author's calculations

CONCLUSIONS

The production structure of countries has an important role on the economic development of countries. For this reason, the index of economic complexity takes into account besides others factors the values of the production structure of countries. Also, the development levels of the countries depend on innovation and technology. Countries with a high value of economic complexity tend to grow faster and these values are used in explaining the differences of countries. In the framework of the evaluations, when the economic complexity and economic growth are compared, it is seen that the countries with high ECI value are also developed countries and countries with high per capita income. Regarding the examined countries, Luxembourg, Ireland, Switzerland and Norway are among the countries with the highest per capita income.

In the research of this article was used a panel regression analysis, based on a panel VAR methodology. The study includes OECD countries and the empirical research covers the period from 2000 to 2021. The average per capita GDP growth rate of OECD countries was found to be 2.06, while the average of the economic complexity index was 1.04. Looking at the GDP growth averages for the period 2000-2021 it was observed that the average growth rate in 2009 year was negative almost in all countries due to global financial crisis, while in 2020 because of the Covid-19 pandemic the most of countries fall again in recession. The results of panel VAR model suggest that the economic complexity index (ECI) does not significantly affect the economic growth, whereas the economic growth positively affects the ECI and is statistically significant at 1% level. These results were also confirmed by the causality test, where the null hypothesis that ECI does not granger cause Growth is not rejected, however the hypothesis that economic growth does not granger cause ECI is rejected at 5% significance level. Meaning that there exists a uni-directional causality.

REFERENCES

Abdon, A., Bacate, M., Felipe, J. and Kumar, U. (2010). ‘’Product Complexity and Economic Development’’. Levy Economics Instı- tute of Bard College, Working Paper, No. 616.

Albeaik, S., Kaltenberg M., Alsaleh M. and Hidalgo A. C. (2017). Improving The Economic Complexity Index. Cornell University, Quantitative Finance, 1-21.

Baltagi, B. H. (2014). Econometric Analysis of Panel Data. Fifth Edition. John Wiley & Sons Ltd: United Kingdom.

Balsalobre, J. P. S., Verduras, L. C. and Lanchas, D. J. (2018). Measuring The Economic Complexity at The Sub-National Level Using International and Interregional Trade. Ceprede and L. R. Klein Institute, Universidad Autónoma de Madrid, 28049.

Bai, J. ve Josep Lluis Carrion-i-Silvestre, (2013) “Testing Panel Cointegration with Unobservable Dyanmic Common Factors That Are Correlated with the Regressors”, Econometrics Journal 16, s. 222-249.

Brito, S., N. Magud ve S. Sosa, (2018). “Real Exchange Rates, Economic Complexity, and Investment”, IMF Working Paper 18/107.

Biorn, E. (2017). Econometrics of Panel Data, Methods and Applications. First Edition. Oxford University Press: United Kingdom.

Brito, S., Magud, Nicolas, E., Sosa, S. (2018). ‘’Real Exchange Rates, Economic Complexity, and Investment’’. IMF Working Papers, 18 (107), 1-21.

Britto, G., Romero, Joao, R., Elton, F. and Coelho, C. (2019). ‘’The Great Divide: Economic Complexity and Development Paths in Brazil and Republic of Korea’’. Cepal Review, No: 127, 191-213

Can, M. (2016). “Does Economic Globalization Affect Sophisticated Goods Production: An Empirical Analysis in the Sample of South Korea”. Eskişehir Osmangazi University Journal of FEAS, 11(3), 21-38.

Can, M. and Dogan, B. (2018). "The Relationship between Economic Complexity and Final Development: An Empirical Analysis in the Sample of Turkey". Financial Political & Economic Reviews, 55 (638), 5-16.

Çemrek F. and Emine B. (2014). "Examination of Oil Consumption with Panel Data Analysis on Economic Growth: The Case of European Union Countries and Turkey". International Journal of Alanya Business Faculty, 6 (3), 47-58.

Cestepe, H. and Caglar, O. (2016). "The Relationship between Product Sophistication and Economic Growth: Panel Data Analysis". International Journal of Management, Economics and Business, Special Issue of ICMEB17, 992-1000.

Cetin M. and Ecevit, E. (2010). “The Impact of Health Expenditures on Economic Growth: A Panel Regression Analysis on OECD Countries”. Doğuş University Journal, 11 (2), 166-182.

Support M.A. (2014). Comparison of the Economic Effects of Defense Expenditures for Countries with Different Income Levels: Panel Data Analysis, Gaziantep University, Institute of Social Sciences, Department of Economics, Unpublished Master's Thesis, Gaziantep.

Felipe, J., Kumar, U., Abdon, A. and Bacate, M. (2012). “Product Complexity and Economic Development”. Structural Change and Economic Dynamics, 23 (1), 36-68.

Ferrarini, B. and Scaramozzino, P. (2013). "Complexity, Specialization and Growth". US Economics Working Paper Series, No. 344.

Ferraz, D., Fernando H. M., Suarez J. C., Riberio F. C. de O. and Nascimento D. A. R. (2018). "Economic Complexity and Human Development: DEA Performance Measurement in Asia and Latin America". Gestao Produçao, Sao Carlos, 25 (4), 839-853.

Gala, P., Rocha, I. and Magacho, G. (2016). “The Structural Revenge: Economic Complexity as an Important Dimension to Evaluate Growth and Development”. Sao Paulo School of Economics, Working Paper, No: 436.

Gao, J. and Zhou, T. (2017). "Quantifying China's Regional Economic Complexity". University of Electronic Science and Technology of China, No: 1703-01292, 1-14.

Greene H. W. (2010). Econometric Analysis. International Edition: New York.

Hartmann, D., Guevara, R. M., Jara-Figueroa, C., Aristaran, M. and Hidalgo A. C. (2017). ‘’Linking Economic Complexity, Intitut- tions, and Income Inequality’’. Word Development, 93, 75-93.

Hatemi-J A. (2012). ‘’Asymmetric Causality Test With An Application’’. Empir Econ, United Arab Emirates, No: 43, 447-456.

Hatemi-J A. (2014). ‘’Asymmetric Panel Causality Test With An Application to The Impact of Fiscal Policy on Economic Perfor- mance in Scandinavia’’. MPRA Paper, Munich Personal RePEc Archive, No: 55527, 1-11.

Hatemi-J, A. and Youssef El-K. (2016). ‘’An Extension of The Asymmetric Causality Test For Dealing With Deterministic Trend Components’’. Applied Economics, 48 (42), 1-9.

Hausmann, R. and Hidalgo, A. C. (2010). ‘’Country Diversification Product Ubiquity and Economic Divergence’’. Faculty Research Working Paper Series, Harward Kennedy School, No. RWP10-045. 1-43.

Hausmann, R., Hidalgo, A. C., Bustos, S., Coscia, M., Chung, S., Jimenez, J., Simoes, A. and Yıldırım, A. M. (2011). The Atlas Economic Complexity Mapping Pats to Prosperity. Massachusetts Institute of Technology and Center for International Development Harvard

Hidalgo, A. C. (2009). ‘’The Dynamics of Economic Complexity and The Product Space Over a 42 Year Period’’. Center for Inter- national Development at Harvard University, Working Paper, No: 189.

HidalgoA.C.andHausman,R.(2009).‘’TheBuildingBlocksofEconomicComplexity’’.CenterforInternationalDevelopmentand Harvard Kennedy School, Harvard University, 106 (26), 10570-10575.

Ivanova, I., Strand, Q., Kushnir, D. and Leydesdorf, L. (2017). ‘’Economic and Technological Complexity: A Model Study of Indı- cators of Knowledge-Based Innovation Systems’’. Institute for Statistical Studies and Economics of Knowledge, National Research University. Technological Forecasting and Social Change, 120, 77-89.

Jinn B. C. W. and Shuhaimen M. S. (2018). ‘’Complexity and Growth: Malaysia’s Position and Policy Implication’’. Economic De- partment, Bank Negara Malaysia, Central Bank of Malaysia, 1-10.

Karadaş, N. and Soyyiğit, S. (2019). "The Relationship Between the Middle Income Trap and the Level of Economic Complexity: A Study on Turkey and Selected Countries". Journal of the Faculty of Applied Sciences, 1 (1-2), 1-23.

Kılıç, C. ve Balan, F. (2019). ‘’Economic Complexity and Economic Growth: Panel ARDL Analysis for Sellected OECD Countries’’. V. International Conference On Applied Economics and Finance, Kyrenia, Kuzey Kıbrıs Türk Cum. 96-105.

Morrison, G., Buldyrev, V. S., Imbruno, M., Arrieta, O. A. D., Rungi, A., Riccaboni, M. and Pammolli, F. (2017). ‘’On Economic Complexity and The Fitnessnof Nations’’. Scientific Reports, 7 (1), 1-11.

Ngarava, S. (2021). ‘’Reletionship Between Economic Diversification and CO2 Emissions: ARDL-EC Modeling in South Africa’’. Development Studies Research, 8 (1), 264-279.

OEC, Observatory of Economic Complexity, The World’s Leading Data Visualization Platform For İnternational Trade Data. Eri- şim: 3 Mayıs 2020, https://oec.world/

OECD, iLibrary, Erişim: 5 Temmuz 2021, https://www.oecd-ilibrary.org/

Öksüzkaya, M. (2013). Income-Consumption Relationship for Selected EU Countries: Panel Data Approach, Unpublished Master's Thesis, Çukurova University, Institute of Social Sciences, Adana.

Philipp, K. (2021). "Economic Complexity and Growth: Can Value-Added Exports Better Explain The Link?". Economic Letters, 198, 1-4.

Pesaran, M. H. (2004). "General Diagnostic Tests for Cross Section Dependence in Panels". University of Cambridge & USC, No: 1240, 1-39.

Pesaran, M. H. (2007). “A Simple Panel Unit Root Test in The Presence of Cross-Section Dependence”. Journal of Applied Econometrics, 22 (2), 265-312.

Pesaran, M. H. and Yamagata, T. (2008). "Testing Slope Homogeneity in Large Panels". Journal of Econometrics, 142 (1), 50-93.

Poncet S. and Waldemar, F. S. D. (2013). “Export Upgrading and Growth: The Prerequisite of Domestic Embeddedness”. World Development, 51, 104-108.

Rodrik, D. (2006). "What's So Special About China's Exports". NBER Working Paper, No: 11947, 1-27.

Rojas, H. L. and Correa, J. C. (2021). “Economic Complexity, Economic Growth and CO2 Emissions: A Panel Data Analysis”. International Economic Journal, 35 (4), 411-433.

Rojas, H. L., Fletcher, D. A. G. and Murillo, A. C. (2021). “Economic Growth, Economic Complexity and Carbon Dioxide Emissions: The Case of Colombia”. Helion, 7 (1), 1-4.

Soyyigit, S. (2018). “The Relationship Between Level of Economic Complexity and GDP Per Capita in OECD Countries: Panel Co-integration Analysis”. Selcuk University Journal of Social Sciences Vocational School, 21 (2), 374-392.

Stojkoski, V. and Kocarev, L. (2017). “The Relationship Between Growth and Economic Complexity: Evidence from Southeastern and Central Europe”. MPRA Paper, No: 77837, 1-25.

Şahin, D. and Durmus, S. (2020). "Determinants of the Level of Economic Complexity in Newly Industrialized Countries". ODU Journal of Social Sciences Research, 10 (2), 334-351.

Tacchella A., Matthieu C., Guido C., Andrea G. and Luciano P. (2012). A New Merics For Countries' Fitness and Products' Complexity. Scientific Reports, DOI: 10.1038/srep00723, 1-723.

Tacchella A., Matthieu C., Guido C., Andrea G. and Luciano P. (2013). "Economic Complexity: Conceptual Grounding of A New Metrics for Global Competitivenes". Journal of Economic Dynamics and Control, 37 (8), 1683-1691.

Tatoglu, F. Y. (2012). Advanced Panel Data Analysis: Stata Applied. Beta Release: Istanbul.

Tatoglu, F. Y. (2013). Panel Data Econometrics Applied to Stata. 2nd Edition, Beta Publication: Istanbul - 58 –

Westerlund, J. and Edgerton L. D. (2007). ‘’A Panel Bootstrap Cointegration Test’’. Economics Letters, 97(3), 185-190.

Westerlund, J. (2008). Panel Cointegration Test of The Fisher Effect. Journal of Applied Econometrics, DOI: 10.1002/jae967, 23, 193-233.

World Bank, (2021a). Global Economic Prospects, January 2021, Chapter 1, 1-64. Erişim: 5 Haziran 2021, https://openknowledge. worldbank.org/handle/10986/34710

World Bank, (2021b). Global Economic Prospects, June 2021, Chapter 1, 1-48. Erişim: 5 Temmuz 2021, https://www.worldbank. org/en/publication/global-economic-prospects

World Bank, World Development Indicators, Erişim: 5 Temmuz 2021, https://databank.worldbank.org/reports.aspx?source=wor- ld-development-indicators

Yıldız, G. and Yıldız, B. (2019). "The Relationship Between Economic Complexity and Economic Growth: Panel Bootsrap Granger Causality Analysis". International Journal of Management, Economics and Business, 15 (2), 329-340.

Zhu, S. and Li, R. (2017). ''Economic Complexity, Human capital and Economic Growth: Empirical Research Based on Cross- Country Panel Data''. Applied Economics, 49 (38), 3815-3828.

T.R. Ministry of Foreign Affairs, http://www.mfa.gov.tr/iktisadi-isbirligi_ve-gelisme-teskilati-_oecd_.tr.mfadate 06.08.2018.

WORLDBANK https://data.worldbank.org/indicator#topic-14 accessed 27.07.2018. Yerdelen Tatoğlu, F., (2013) Advanced Panel Data Analysis Stata Applied, 2nd edition, Beta, Istanbul