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SECTORAL GROWTH DYNAMICS OF COUNTRY GROUPS: A COUNTRY GROUPING SUGGESTION

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Selcuk Alp[1], Elcin Aykac Alp[2], Tugba Kiral Ozkan[3], Mefule Findikci Erdogan[4]
[1]Yıldız Technical University, Faculty of Mechanical Engineering, Department of Industrial Engineering, Istanbul, Turkiye.
alp@yildiz.edu.tr , ORCID: 0000-0002-6545-4287
[2]Istanbul Ticaret University, Faculty of Business, Department of Economics, Istanbul, Turkiye.
ealp@ticaret.edu.tr , ORCID: 0000-0001-9076-2102
[3]Bahcesehir University, Faculty of Educational Sciences, Istanbul, Turkiye.
tugba.kiral@es.bau.edu.tr , ORCID: 0000-0002-7050-3805
[4]Istanbul Ticaret University, Institute of Finance, Istanbul, Turkiye.
mfindikci@ticaret.edu.tr , ORCID: 0000-0003-0150-0990

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ABSTRACT

Purpose- In the study, the effects of sectors on the growth of OECD member countries were determined by using the Fuzzy Goal Programming method. These findings may help policymakers see sector impacts that help countries in their growth targets. The study aims to contribute to the literature in two ways. The first of these analyses are based on long-term economic growth and primary sector analysis. The second contribution is to propose an alternative empirical methodology with clustering analysis which is not used to obtain the basic assumption of homogeneity in the application of panel data analysis.
Methodology- The effects of sectors on the growth of OECD member countries were determined by using the Fuzzy Goal Programming method. In the second step, countries were divided into groups using K-means clustering analysis according to these impact values. With the help of these weights, the growth dynamics of similar countries and the contributions of sectors to this dynamic were obtained.
Findings- Countries analyzed in terms of the contribution of sectoral growth rates to the growth rate of the country were divided into groups by cluster analysis. It is determined that the countries grouped in terms of the contribution of sectors to growth are divided into 5 groups. The first group has 10 member countries. The second group has 12 countries and the third group it has 7 countries, the fourth group has 4 countries and only 1 country belongs to the fifth group. The countries in group 1 are Estonia, Turkey, Greece, Italy, Poland, Portugal, Lithuania, Latvia, Slovakia, and Slovenia. The countries in group 2 are Australia, Belgium, Czech Republic, Germany, Denmark, Hungary, Ireland, Mexico, Netherlands, Norway, Sweden, and New Zealand. The countries in group 3 are Austria, Spain, Finland, France, the Republic of Korea, Luxembourg, Switzerland, the USA, Israel, Costa Rica, the United Kingdom, and Japan.
Conclusion- Countries that have similar sectoral structures can analyze growth with panel data analysis, but it is important to form homogeneous groups while doing this analysis. For this reason, another critical suggestion it is offered based on the study is the use of FGP methodology in the analysis method.

Keywords: Economic growth, sectoral growth, Fuzzy Goal Programming, Cluster Analysis, Panel VAR
JEL Codes: N10, C61, C38, C33

1. INTRODUCTION

The studies in the field of growth generally examine the relations between countries' growth rates and other economic and social indicators. Although there are many theoretical and applied studies investigating the dynamics of economic growth, some of these studies reveal the effect of the change and transformation of the sectoral structure on growth. The dynamics of the growth of countries go through certain stages and reveal the effects of the sectors on growth and development in these studies.

One of the most important studies conducted recently is the work of Zeira and Zoabi (2015). This study divides the sectors into traditional and modern sectors and highlights the importance of the increase in productivity in modern sectors.

While Fisher's (1939) study focused on production, the three-sector theories extended by Clark (1940) reveal the gradual development and support of the agriculture, industry, and services sectors. The discussion that continued with the study of Kuznets (1966), followed by Gershuny and Miles (1983), draws attention to the services sector development that started before the industrial sector growth was completed and that the two sectors grew together.

Due to the increase in the share of the knowledge economy in the countries and the importance of specialization, many sub-sectors that can form the engine of growth, accelerate and even prevent growth in the main sectors gain importance.

The issue of growth is related to many factors and takes place with different dynamics in different countries. However, it is known that countries have similar growth dynamics with each other. Based on this idea, it is seen that countries are analyzed together in the literature. In this study, an analysis structure is suggested based on the idea that countries with similar sectoral structures should be grouped before examining countries in terms of the contribution of sectors to growth.

In the second part of the study, literature review was made, in the third part, theoretical information about the analysis methods, and in the fourth part, the findings were reported.

2. LITERATURE REVIEW

From this perspective, there is literature that examines the effects of sectors on growth. It is specially tested that the industry and the manufacturing industry are engines of growth. This research question is based on Kaldor's "first law of growth" which puts forth a positive relationship between the output growth of the manufacturing sector and the GDP growth (Kaldor, 1966).

With this point of view Chakravarty, and Mitra, (2009) study aimed to examine if the manufacturing sector is still the engine of growth. They used the VAR model and especially variance decomposition analysis for testing their hypothesis. Variance decomposition analysis is used for the interrelation information between sectors. They examined that the manufacturing, construction, and services sectors are the three main drivers of Indian growth for the period they analyzed. In addition, two important studies are testing the impact of the difference between industry and agricultural growth. Those are Bhattacharya and Mitra (1989, 1990) studies. Bhattacharya and Mitra (1989) study analyse the pattern of growth of the tertiary sector and its implications on growth and distribution in India for the period 1950 to 1987. Bhattacharya and Mitra (1990) study also analyzed the period 1950 to 1987 and concluded that the services sector in India grew much faster than the commodity sector for this period.

Szirmai and Verspagen (2015) analyzed the relationship between manufacturing and economic growth in 88 countries for the period of 1950–2005. They used panel data models, and they tested if manufacturing acted as an engine of growth. They found that after 1990 manufacturing decreases the importance of being the engine of growth for intermediate levels of developing countries.

Su and Yao (2016) indicate that the manufacturing sector has the main role in economic growth for middle-income economies and if manufacturing sector production growth decreases it will negatively affect the growth of all other sectors.

Haraguchi, Cheng, and Smeets (2017) study also analyzed the importance of the manufacturing sector on growth and determined the decreasing effect of this sector on growth for developing countries. Their investigation takes into account the three sectors: manufacturing, agriculture, and service sectors. The analysis is also constructed for different periods. The hypotheses of this study are, "manufacturing is no longer the driver of economic growth in developing countries", and the second is "the share of manufacturing value-added relative to other sectors and employment has decreased significantly in developing countries".

Karami, Elahinia, and Karami (2019) studied 25 European economies for the period 1995-2016. They analyzed the effect of the manufacturing sector on economic growth and find a positive significant relationship between manufacturing, labor force and technology. They used panel data models for this sample.

In this context, it is important to examine the effects of countries' growth rates on total growth and thus reveal the dynamics of growth in countries. In this context, examining and grouping the sectoral sizes of countries that are at different levels in the stages of growth and development will also inform us about which sectors are in the foreground and the speed of growth increases.

This study analyses the effects of sectoral growth rates on total growth for each country and the sectoral structure of the growths of countries is revealed. In addition, countries are grouped according to these impact values.

The relationship between sectoral growth rates and total growth rate is based on historical data, and each sector has been included in the model in proportion to its share of the GDP. Using the Fuzzy Goal Programming (FGP) method, the impact of each sector on total growth was calculated. In the proposed model, the impact value of the growth rates in the sectors are considered as decision variables, and the total growth rates of the countries are considered as target values. A separate mathematical model has been created for each country.

In the created models, the growth rates of countries in the sectors (for the period 2000-2017) were used as the coefficients of the decision variables. 10% of each target value was accepted as the tolerance value for the fuzzy model and the impact values of each sector growth rate to the total growth rate were calculated using the FGP method and the Hannan approach.

Using the obtained impact values, countries are divided into different groups by K-means cluster analysis. The growth structure of each group was examined with the Panel VAR model. As a result of the grouping, the structure of growth for each group is revealed, and the differences between the growth structures of OECD countries according to the sectors that affect growth are grouped.

In a study on this subject, the use of time series will undoubtedly create important information contributions, but it was decided to analyze the common structure countries together by applying the panel data model with both time and cross-section structure with the idea that it would be wrong to act on a single country model.

In the FGP method, the effects of the growth rates in the sectors on the GNP were determined for the OECD countries by using the Hannan approach. Countries were divided into groups by hierarchical cluster analysis using these impact values (effects of each sector on GNP growth rate). The structure of the growth is revealed for each group obtained as a result of grouping. In this way, the differences between the growth structures of OECD countries according to the sectors that affect growth are determined.

It is aimed to determine the common characteristics of the clusters in which countries are included and to reveal the structure of their growth dynamics. For this purpose, the groupings of countries whose sectors, which are the engines of growth, are similar provide important information about the growth dynamics of the countries. The information and findings to be obtained in line with this goal will contribute to the literature in two areas.

The first contribution is providing different types of prescriptions to policymakers by making different suggestions in decisions to be taken for the target of growth in different country groups and by choosing different growth engine sectors.

The second important contribution is a suggestion presented in terms of the empirical method. The applied analysis is a suggestion for the solution to the problem of not being able to form homogenous groups, which is one of the most important assumptions in panel data analysis. This suggestion is to incorporate the FGP method into the analyzing process, which enables cluster analysis to form homogenous groups in panel data analysis.

3. DATA AND METHODOLOGY

In the study, growth data belonging to 34 OECD countries are used. This data covers total and sectoral growth rates for those countries and the 18 years of OECD countries statistics between 2000-2017. This period is selected because this period allows analyzing the maximum time and country composition of OECD countries because of data availability.

The main objective of the study is to find the most significant sectors in the growth of the countries and to examine the effects of each sector on long-term growth. Since it would not be right to investigate this information from a single country, it is thought that similar countries should be examined together. For this reason, panel data analysis is planned to perform.

One of the basic assumptions of panel data analysis is the analysis of the homogeneity of groups. OECD countries can be analyzed to ensure the homogeneity assumption. However, since it is considered the growth structure will vary within OECD countries, it is decided to use clustering analysis for the country grouping process. To make cluster analysis, weights were calculated with fuzzy goal programming. After this step, Panel unit root and Panel VAR analyses were applied to the groups determined by clustering analysis.

3.1. Fuzzy Goal Programming

Goal Programming (GP) is based on the study of Charnes and Cooper (1961), Lee (1972), and Ignizio (1976). After these studies, many studies were carried out in different fields using GP. Some of the studies in different fields using GP can be exemplified as follows: Financial analysis (Charnes et al., 1963, El-Sheshai et al., 1977), media planning (Charnes et al., 1968), academic resources allocation (Lee and Clayton, 1972), location preferences (Courtney et al., 1972), product planning (Forsyth, 1969).

GP is one of the Multiple Criteria Decision-Making techniques used to solve multi-objective problems, minimizing deviations from the desired target for each target (Steuer, 1986). Objectives express the wishes of decision-makers. Targets are expressed as a numerical value of the objective to be achieved (Schnierdejans, 1984). GP is to achieve as much as possible a satisfying solution to the desired objectives in the problem. GP offers an efficient and mostly satisfactory solution rather than the optimal solution to the problem. The main difference between Linear Programming (LP) and GP is that while LP maximizes or minimizes a single objective function, GP minimizes deviations from target values (Schnierdejans, 1984).

In the GP model, there are positive (p_i) and/or negative (n_i) deviational variables for each objective. The value (n_i) represents an underachievement from (G_i: target values), while the value (p_i) represents an overachievement. For each target, at least one of (p_i) or (n_i) must be equal to zero.

The general GP model stated as:

$$\left.\begin{array}{ll} \textit{Objective Function} & \\ \min \sum_{k=1}^{r}\left(P_k\left(\sum_{t=1}^{s} w_{tk}^{+} p_t + \sum_{t=1}^{s} w_{tk}^{-} n_t\right)\right) & \\ \textit{subject to} & \\ \sum_{j=1}^{n} a_{ij}.x_j = b_i, & i=1,2,...,m \\ \sum_{j=1}^{n} c_{tj}.x_j + n_t - p_t = G_t, & t=1,2,...,s \\ x_j \geq 0, & \textit{for all } i \\ n_t, p_t \geq 0, & \textit{for all } t \\ n_t \times p_t = 0, & \textit{for all } t \end{array}\right\} \quad (1)$$

where

x_j : The jth decision variables,
a_{ij} : Coefficients of decision variables j of constraint i,
b_i : The right-hand side constant for constraint i,
c_{tj} : Coefficients of decision variables j of goal t,
G_t : The right-hand side constant for goal t,
n_i : Negative deviational variables,
p_i : Positive deviational variables,
P_k : Preemptive priority ($P_1 > P_2 > \ldots > P_r$ for k=1,2,…,r).
w^-_{ik} : The weight value of the t*th* negative deviation variable for the k*th* priority in the objective function,
w^+_{ik} : The weight value of the t*th* positive deviation variable for the k*th* priority in the objective function,

GP model consists of objective functions, target values, and crisp constraints. Determining these values is a difficult and subjective process. The subjectivity can be considered as fuzzy set theory. When the GP model is considered in the context of fuzzy set theory, expressions such as "approximately equal to" and "fairly large" can be used for target values. Such expressions are handled by membership functions in fuzzy sets theory.

When the fuzzy set theory is applied to the GP model, the target value and preference priorities of targets can be characterized by uncertain expressions (fuzzy). In such cases, it would be appropriate to use FGP (Venkatasubbaiah et al., 2011).

In the approach developed by Hannan, fuzzy targets are characterized by symmetrical triangular membership functions. In this approach, the FGP model is formulated as the LP Model with the theorem $\lambda^* = \max \lambda_j ; j = 1,2,...,2^{m1}$. Where λ_j refers to the solution values of the sub-problems and λ^* is the highest member of the fuzzy decision set. (Hannan, 1981).

In Hannan approach, a tolerance value is determined for the target values. This value is taken as the coefficient of positive and/or negative deviation variables in target constraints. Constraints of performance level and deviation variables of less than one for each objective are added to the model. The objective function is set to maximize the performance level.

With the Hannan approach, the FGP model can be expressed as a LP problem as follows (Hannan, 1981);

$$\left.\begin{array}{l}\max \lambda \\ \text{constraints} \\ \dfrac{(Ax)_i}{d_i} + n_i - p_i = \dfrac{b_i}{d_i} \\ \lambda + n_i + p_i \le 1 \\ n_i \times p_i = 0 \\ x_i, \lambda, n_i, p_i \ge 0 \qquad i = 1,2,...,m \qquad j = 1,2,...,m \end{array}\right\} \tag{2}$$

(Ax)$_i$: Objective function,
b_i : Target value
n_i : Negative deviation variables,
p_i : Positive deviation variables,
λ : Performance level

3.2. Partition Based Clustering

Partition Based Clustering algorithms take the input parameter k and divide n objects into k sets. These techniques perform operations that find single-level clusters (Jain et al., 1999). All clustering techniques are based on the central point representing the cluster. Partition-based methods produce good results because their applicability is both easy and efficient.

One of the Partition Based Clustering Algorithms K-means was developed by J.B. MacQueen (1967). The assignment mechanism of K-means, one of the most commonly used unsupervised learning methods, allows each data to belong to only one cluster. Therefore, it is a sharp clustering algorithm (Han and Kamber, 2001).

In the evaluation of the K-means clustering method, the most common squared error criterion SSE is used. Clustering with the lowest SSE gives the best result. The sum of the squares of the distance of the objects to the center points of the cluster is calculated by equation (3) (Pang-Ning et al., 2006).

$$SSE = \sum_{i=1}^{K} \sum_{x \in C_i} dist^2(m_i, x) \tag{3}$$

As a result of this criterion, k clusters are as dense and separate from each other as possible. The algorithm tries to reduce the k part to determine by the squared-error function. The K-means algorithm divides the data set consisting of n data and n data by k parameter into k sets. Cluster similarity is measured by the average value of objects in the cluster, which is the center of gravity of the cluster (Xu and Wunsch, 2005).

3.3. Unit Root Tests for Panel Data

The panel data has two dimensions, those are cross-sectional dimension and time dimension. It is necessary to investigate the stationarity structure of the data before cointegration analysis like conventional time series analysis. To this end, many different panel unit root tests have been developed. Dickey Fuller (1979) and Augment Dickey-Fuller (ADF) test approaches were used to establish the hypotheses and to calculate the test statistics (Guris, 2018, 261; Breitung and Das, 2005).

In the literature, panel unit root tests are called the first generation if the data has cross-section independence. However, panel unit root tests are called the second generation if they are based on the horizontal cross-sectional dependency hypothesis.

First-generation panel unit root tests are applied if there is no correlation between cross-section units. Dickey Fuller (1979) and Augmented Dickey-Fuller (ADF) are based on the test approach. In this study, Levin, Lin and Chu (2002) test, Im, Peseran and Shin (2003) unit root test study and based on ADF Fisher and PP Fisher tests were applied. Panel unit root tests generally test the data for how the current period is affected by the previous periods. For a Y series, this can be examined using the following equation:

$$\Delta Y_{it} = \rho_i Y_{it-1} + \sum_{j=1}^{m_i} \beta_j \Delta Y_{it-j} + yZ_{it} + \varepsilon_{it} \tag{4}$$

m_i represents the optimal lag length, ρ_i unit root parameter, Z_{it} components such as constant term and trend that affect the stability of the Y series, and ε_{it} error terms.

The second-generation unit root tests are used in the panel data models if the cross-section dependency hypothesis is failed to reject. The main feature of the second-generation unit root tests is that it assumes a cross-sectional correlation. The main second generation unit root tests are Bai and Ng (2002, 2004), Moon and Perron (2004), Phillips and Sul (2003), Choi (2002) and Pesaran(2007) (Hurlin and Mignon, 2007).

Pesaran (2007) CADF test, which is used in the study, is an extended version of ADF regression with the first differences of the individual series and the cross-sectional mean of the lag levels. In the test, both the individual results of each cross-section are obtained by CADF statistic and CIPS (Cross sectionally IPS) statistics are obtained by getting the average of cross-sections and the results are obtained for the whole panel. The CADF test provides very consistent results even when the horizontal cross-section (N) and time (T) dimensions are relatively small. In addition, this test can be used when both $T> N$ and N>T (Pesaran, 2007, 265-312).

3.4. Panel Vector Autoregression Analysis (Panel VAR)

One of the first studies in the literature on the Panel VAR model was by Holt-Eakin, Newey and Rosen (1988). This model was created by adding the horizontal cross-sectional dimension to the traditional VAR model introduced by Sims (1980). It consists of a set of equations instead of a single equation in the VAR system, which accepts all variables in the system as endogenous and independent. The panel VAR model also derives asymptotic results to be included in the model for unobservable cross-sectional effects. Under the assumption that all variables are endogenous, the panel VAR model with maximum p lag length, which is formed with panel data, is expressed as follows (Canova and Ciccarelli, 2013, Guris, 2018; Holtz-Eakin, Newey and Rosen, 1988).

$$y_{it} = \sum_{j=1}^{j} a_{11j} y_{it-j} + \sum_{j=1}^{j} a_{12j} x_{it-j} + \lambda_{1i0} + \lambda_{10t} + e_{1it} \tag{5}$$

$$x_{it} = \sum_{j=1}^{j} a_{21j} y_{it-j} + \sum_{j=1}^{j} a_{22j} x_{it-j} + \lambda_{2i0} + \lambda_{20t} + e_{2it}$$

In the equation, j represents the maximum lag length, λ_{1i0} and λ_{2i0} indicates unit effects, λ_{10t} and λ_{20t} shows the unobservable time effects (Guris, 2018).

Structural shocks which are analyzed by impulse-response and variance decomposition analysis can be examined with error terms in VAR models. The response of one variable to other variables is realized by analysis of coefficients in the impulse-response system which the short-term effects are estimated. The relationship between the variables in the PVAR models can also be interpreted by Variance Decomposition analysis. The variance decomposition analysis gives information about the effect of structural shocks on the total variance of each variable.

4. FINDINGS AND DISCUSSIONS

Abbreviations used in analysis are TOT; Total growth, AGR; Agriculture, CON; Construction, FIN; Finance, IND; Industry, INF; Information, MFG; Manufacturing, OTH; Other Services, PRO; Professional, Scientific, Support services, PUB; Public administration, defense, education, health, social work, REAL; Real estate sector, WHL; Wholesale, retail trade, repairs, transport.

As it's mentioned before in order to get homogenous groups for the analysis, firstly it is used fuzzy goal programming and gets the main growth equations weights for each country. The main findings of this analysis are given in the Appendix (App. 2). The weights found by the fuzzy goal programming method are used in k-means clustering for finding main groups of countries. Results for K-means clustering analysis are also given in the appendix (App. 3). Panel Cross-Section Dependency Test, Panel unit root and Panel VAR analysis results are given below. Table 1 gives the panel cross-section dependency test results for data.

Table 1: Panel Cross-Section Dependency Test

		Pesaran (2004) CD test (N>T)		
OECD group	1.23	0.220	$h_0 = \rho_{ij} = \rho_{ji} = 0$ $h_a = \rho_{ij} = \rho_{ji} \neq 0$	$i \neq j$
		Breusch-Pagan LM test of independence (T>N)		
	X^2	p		
Group 1	63.633	0.0350	$h_0 = \rho_{ij} = \rho_{ji} = 0$	$i \neq j$
Group 2	109.540	0.0006	$h_a = \rho_{ij} = \rho_{ji} \neq 0$	
Group 3	18.598	0.6109		

The results of the analysis show that the null hypothesis, which expresses cross-section independence, failed to reject the OECD countries' group and group 3 but rejected group 1 and group 2. Namely, there is no cross-sectional dependency for the OECD countries' group and group 3. Therefore, stationarity testing of variables in the data set should be performed with first-generation unit root tests for these groups. However, there is a cross-sectional dependency between group 1 and group 2. Hence, stationarity testing of variables in the data set should be performed with second-generation unit root tests for those groups. Besides, these dependency results indicate that a shock in the total growth data (TOT) may be affected differently by other shocks for the countries in group 1 and group 2. This also means main research question may have different answers for different groups. This implication is also important because if it been had done the traditional panel data analysis, it would have taken all OECD countries as a single group, and this would prevent from recognition of different group types.

The results in Table 2 indicate that the data used in the analysis are stationarity for all groups. The variables are stationarity in the level form (I(0)). This result also gives signs of the appropriate analysis it can be used. The Panel VAR model is used for determining the relationship between variables. The appropriate lag length for the estimation of the Panel VAR model is chosen by using information criteria. The AIC, BIC, LR, and HQIC information criteria are used, and the results are given in the appendix (App. 4). The results indicate that, according to the information criteria, the appropriate lag length was determined as 3 for the first model which all countries were taken into consideration, 4 for the second model (Group 1), 1 for the third model (Group 2) and 2 for the last model (Group 3). For the stability analysis of the predicted Panel VAR model, the eigenvalues are less than one. As a result of the test of this condition, it is seen that the eigenvalues of all the characteristic roots of the Panel VAR model are below one. This result also can be seen according to the Inverse Roots Graphs given in the appendix.

Table 2: First Generation Unit Root Test Results

		OECD group		
	Levin, Lin & Chu t*	**Im, Pesaran and Shin W-stat**	**ADF - Fisher Chi-square**	**PP - Fisher Chi-square**
TOT	-9.534	-8.048	185.758	272.939
	0.000	0.000	0.000	0.000
AGR	-15.906	-15.107	335.854	1304.580
	0.000	0.000	0.000	0.000
CON	-6.938	-6.802	163.052	205.207
	0.000	0.000	0.000	0.000
FIN	-4.673	-6.696	168.564	332.487
	0.000	0.000	0.000	0.000
IND	-11.378	-9.952	225.214	406.544
	0.000	0.000	0.000	0.000
INF	-8.746	-9.204	211.575	565.807
	0.000	0.000	0.000	0.000
MFG	-12.804	-10.623	239.297	413.979
	0.000	0.000	0.000	0.000
OTH	-5.820	-8.248	191.279	403.984
	0.000	0.000	0.000	0.000
PRO	-9.868	-9.449	214.931	349.374
	0.000	0.000	0.000	0.000
PUB	-6.410	-5.850	144.408	247.468
	0.000	0.000	0.000	0.000
REAL	-7.471	-8.476	200.211	426.926
	0.000	0.000	0.000	0.000
WHL	-11.606	-9.819	222.204	371.552
	0.000	0.000	0.000	0.000
		Group 3		
	Levin, Lin & Chu t*	**Im, Pesaran and Shin W-stat**	**ADF - Fisher Chi-square**	**PP - Fisher Chi-square**
TOT	-5.369	-4.332	44.389	70.884
	0.000	0.000	0.000	0.000
AGR	-9.942	-9.375	94.362	446.940
	0.000	0.000	0.000	0.000
CON	-3.404	-3.502	37.991	50.333
	0.000	0.000	0.001	0.000
FIN	-1.607	-3.085	34.589	108.881
	0.054	0.001	0.002	0.000

IND	-6.473	-5.133	51.851	95.807
	0.000	0.000	0.000	0.000
INF	-4.495	-5.122	51.670	72.647
	0.000	0.000	0.000	0.000
MFG	-7.917	-6.248	62.915	114.670
	0.000	0.000	0.000	0.000
OTH	-0.226	-3.688	39.092	126.536
	0.411	0.000	0.000	0.000
PRO	-5.718	-4.172	42.727	77.254
	0.000	0.000	0.000	0.000
PUB	-3.620	-3.421	37.653	76.623
	0.000	0.000	0.001	0.000
REAL	-4.591	-4.646	48.014	84.601
	0.000	0.000	0.000	0.000
WHL	-4.392	-4.535	46.788	140.947
	0.000	0.000	0.000	0.000

The first raw for each variable indicates the critical test value and the second raw gives the probability values for this variable for individual unit root test.

Table 3: Second Generation Unit Root Test Results for Group 1 and Group 2

			Group 1			
	t-bar	**cv10**	**cv5**	**cv1**	**Z[t-bar]**	**P-value**
TOT	-2.939	-2.210	-2.340	-2.600	-3.712	0.000
AGR	-5.218	-2.210	-2.340	-2.600	-10.708	0.000
CON	-3.616	-2.210	-2.340	-2.600	-5.791	0.000
FIN	-3.789	-2.210	-2.340	-2.600	-6.320	0.000
IND	-3.004	-2.210	-2.340	-2.600	-3.911	0.000
INF	-4.236	-2.210	-2.340	-2.600	-7.693	0.000
MFG	-2.815	-2.210	-2.340	-2.600	-3.331	0.000
OTH	-3.992	-2.210	-2.340	-2.600	-6.944	0.000
PRO	-3.930	-2.210	-2.340	-2.600	-6.753	0.000
PUB	-3.166	-2.210	-2.340	-2.600	-4.408	0.000
REAL	-4.315	-2.210	-2.340	-2.600	-7.935	0.000
WHL	-3.424	-2.210	-2.340	-2.600	-5.199	0.000
			Group 2			
	t-bar	**cv10**	**cv5**	**cv1**	**Z[t-bar]**	**P-value**
TOT	-3.125	-2.140	-2.260	-2.470	-4.669	0.000
AGR	-4.779	-2.140	-2.260	-2.470	-10.287	0.000
CON	-3.419	-2.140	-2.260	-2.470	-5.669	0.000
FIN	-3.401	-2.140	-2.260	-2.470	-5.607	0.000
IND	-3.802	-2.140	-2.260	-2.470	-6.970	0.000
INF	-3.493	-2.140	-2.260	-2.470	-5.918	0.000
MFG	-3.438	-2.140	-2.260	-2.470	-5.733	0.000
OTH	-4.175	-2.140	-2.260	-2.470	-8.237	0.000
PRO	-3.928	-2.140	-2.260	-2.470	-7.396	0.000
PUB	-3.060	-2.140	-2.260	-2.470	-4.448	0.000
REAL	-3.457	-2.140	-2.260	-2.470	-5.796	0.000
WHL	-3.559	-2.140	-2.260	-2.470	-6.144	0.000

Fulfilling the conditions of stability analysis conditions is important in terms of using the Panel VAR model. Since the panel VAR model, which has been pre-tested, is examined the summary table of the four models showing the main model containing the growth variable is given below. Although the statistical significance of all coefficients is not expected for both

VAR and Panel VAR models, the coefficients are generally found statistically significant. Their interpretations were briefly given below.

For each group Panel VAR model has 13 endogenous variables and 13 models for each variable. Because the most important information in this study is the effect of each sub-sector on total growth and to save space, the main equation for total growth is given for each group.

From Table 4 it is seen that the agriculture sector has a negative effect on most of the groups and the effect is quite low in the OECD group. This is also valid in group 2 and 3, but it has a positive effect on group 1 countries. Although the 1st lag of the construction sector variable had a positive effect for all groups on the growth variable, it is determined that the greatest effect was in Group 1. The lag values of the construction sector indicate different effects for different groups. However, the Group 1 countries are positively affected by the relatively traditional production sectors.

The 1st lag of the finance and insurance sector variable has a positive effect on the Growth variable of the OECD group, Group 1 and Group 3, but has a negative effect on Group 2. The effect is the highest impact on Group 1. The effect of lags 2 and 3 of the finance and insurance sector variable is negative for all groups.

The 1st lag of the industry sector variable has a positive effect on growth for the OECD group and Group 1, whereas it has a negative effect on Group 2 and Group 3. The effect is positive in group 3 for the second lag.

The information sector has a positive effect on the Growth variable for the OECD group and Group 1, but a negative effect on Group 2 and Group 3 at the first lag of the Communication sector variable. The sector, like finance where the negative effect is similar to the past periods where the first lag has a positive and greater impact.

The 1st lag of the manufacturing sector has a negative effect on the OECD group, Group 1, and Group 2 on growth, but has a positive effect on group 3. For different lags, the sign of this effect varies in this sector.

While the effect of the 1st lag of the other services sector variable positive effect on the growth variable for all groups, the highest effect is in group 1. The effect of 2nd lag of the other services activities sector variable was negative for the OECD group and Group 1 but positive for Group 3. The effect is the highest for Group 3.

The effect of the 1st lag of the Professional, Scientific, and Support Services sector variable on the growth variable is positive for the OECD group and Group 1, but negative for Group 2 and Group 3. This effect turned negative to the 2nd and 3rd lags for the OECD group, but the positive effects persisted for lags 2 and 4 for group 1. The effect of this sector has a positive effect on Group 3 on the second lag.

The effect of the 1st lag of the sector "Public administration, defense, education, health, social work" on the growth variable was positive for the OECD group, Group 1, and Group 3, but negative for Group 2. The positive impact of this sector, which gives information about the institutional and social structures of the countries, is also an important finding.

The effect of the 1st lag of the real estate sector variable on the growth variable was positive for all models, but it was determined that Group 1 has the highest effect. The effect of this sector can be also analyzed based on groups, it is seen that it has a positive effect for the first lag, but this effect turns negative in the second and third lags for the countries in the OECD group and Group 1 countries.

Wholesale, retail trade, repairs, transport; the effect of the 1st lag of accommodation, food services sector variable on growth variable is positive for OECD group and Group 1, negative for Group 2 and group 3. The highest effect was determined for Group 1.

The analysis of dynamic relationships is carried out through impulse-response analysis and variance decomposition in VAR analysis. In this part of the study, graphs show the response of the total growth variable to the “one standard deviation” shock occurring in the variables of sector growth from the impulse-response functions for the 4 models examined are presented.

Table 4: Panel VAR Model Summary Results of Four Groups

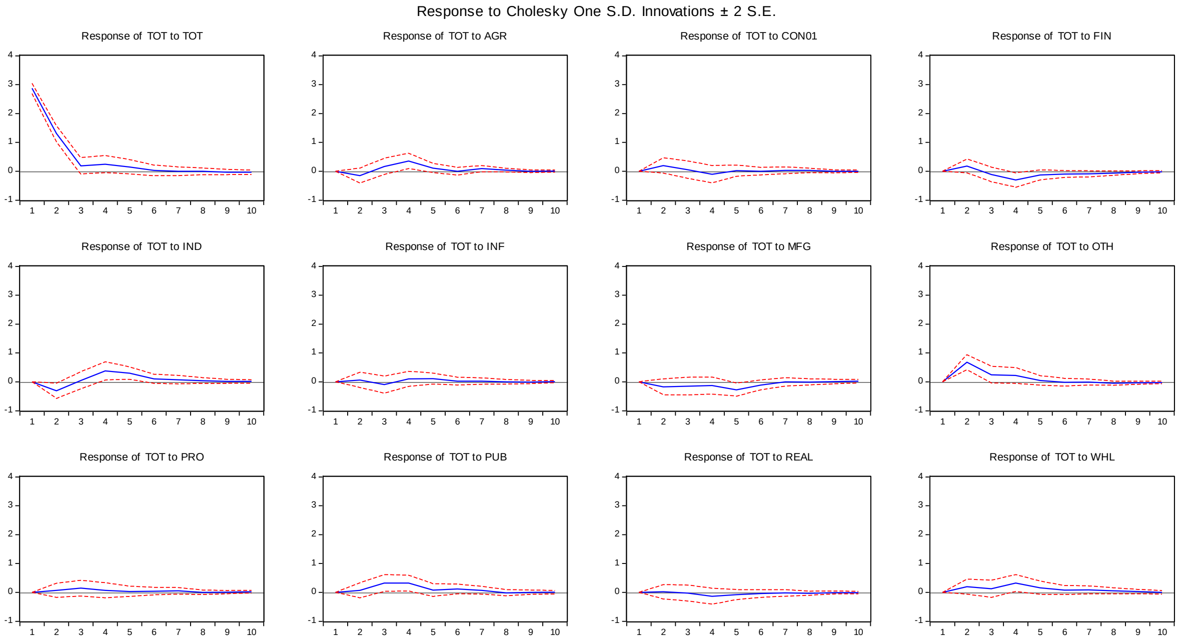
	OECD	**GROUP 1**	**GROUP 2**	**GROUP 3**
	TOT	TOT	TOT	TOT
TOT(-1)	-0.011	-2.43	0.64	0.198
	(0.27)	(0.866)	(0.53)	(0.465)
TOT(-2)	-0.33	-0.74		-0.549
	(0.283)	(0.929)		(0.462)
TOT(-3)	-0.522	0.536		

	(0.282)	(0.972)		
TOT(-4)		-1.118		
		(0.929)		
AGR(-1)	-0.003	0.028	-0.023	-0.062
	(0.016)	(0.058)	(0.023)	(0.021)
AGR(-2)	0.028	0.118		-0.001
	(0.017)	(0.061)		(0.023)
AGR(-3)	0.048	0.092		
	(0.017)	(0.07)		
AGR(-4)		0.048		
		(0.062)		
CON (-1)	0.042	0.153	0.059	0.065
	(0.026)	(0.074)	(0.047)	(0.048)
CON (-2)	-0.002	-0.012		-0.063
	(0.028)	(0.083)		(0.048)
CON (-3)	0.041	-0.108		
	(0.027)	(0.085)		
CON (-4)		0.034		
		(0.079)		
FIN(-1)	0.04	0.178	-0.032	0.14
	(0.023)	(0.066)	(0.038)	(0.056)
FIN(-2)	-0.015	-0.004		-0.004
	(0.023)	(0.058)		(0.055)
FIN(-3)	-0.005	0.005		
	(0.021)	(0.055)		
FIN(-4)		0.027		
		(0.05)		
IND(-1)	0.162	1.179	-0.017	-0.144
	(0.112)	(0.317)	(0.182)	(0.178)
IND(-2)	0.115	-0.253		0.435
	(0.112)	(0.323)		(0.182)
IND(-3)	0.24	0.158		
	(0.109)	(0.332)		
IND(-4)		0.815		
		(0.308)		
INF(-1)	0.026	0.083	-0.041	-0.05
	(0.031)	(0.088)	(0.048)	(0.06)
INF(-2)	-0.019	-0.056		-0.058
	(0.032)	(0.09)		(0.054)
INF(-3)	0.049	-0.111		
	(0.027)	(0.091)		
INF(-4)		-0.018		
		(0.069)		
MFG(-1)	-0.114	-0.565	-0.109	0.084
	(0.081)	(0.237)	(0.1)	(0.148)
MFG(-2)	-0.041	0.479		-0.363
	(0.082)	(0.244)		(0.158)
MFG(-3)	-0.036	-0.069		
	(0.078)	(0.241)		
MFG(-4)		-0.304		
		(0.212)		
OTH(-1)	0.167	0.187	0.106	0.085
	(0.032)	(0.055)	(0.077)	(0.067)
OTH(-2)	-0.029	-0.074		0.136
	(0.033)	(0.057)		(0.077)
OTH(-3)	0.031	0.017		
	(0.031)	(0.059)		

OTH(-4)		0.012		
		(0.049)		
PRO(-1)	0.037	0.147	-0.062	-0.058
	(0.04)	(0.108)	(0.065)	(0.08)
PRO(-2)	0.033	0.006		0.019
	(0.039)	(0.101)		(0.076)
PRO(-3)	0.007	-0.063		
	(0.036)	(0.091)		
PRO(-4)		0.07		
		(0.082)		
PUB(-1)	0.099	0.374	-0.228	0.124
	(0.1)	(0.217)	(0.176)	(0.178)
PUB(-2)	0.191	0.283		-0.05
	(0.103)	(0.244)		(0.17)
PUB(-3)	0.099	0.213		
	(0.094)	(0.222)		
PUB(-4)		0.314		
		(0.214)		
REAL(-1)	0.031	0.273	0.064	0.02
	(0.043)	(0.106)	(0.089)	(0.114)
REAL(-2)	-0.016	0.016		0.228
	(0.045)	(0.114)		(0.104)
REAL(-3)	-0.031	-0.16		
	(0.044)	(0.114)		
REAL(-4)		0.141		
		(0.126)		
WHL(-1)	0.116	1.022	-0.055	-0.028
	(0.076)	(0.262)	(0.125)	(0.124)
WHL(-2)	-0.044	-0.018		0.237
	(0.08)	(0.278)		(0.121)
WHL(-3)	0.131	-0.128		
	(0.083)	(0.293)		
WHL(-4)		0.267		
		(0.279)		
C	1.492	1.118	1.747	1.491
	(0.277)	(0.734)	(0.385)	(0.38)
R-squared	0.321	0.656	0.149	0.443
Adj. R-squared	0.269	0.474	0.095	0.289
Sum sq. resids	3899.784	1023.856	1418.362	245.0347
S.E. equation	2.871	3.354	2.725	1.678
F-statistic	6.204	3.611	2.782	2.877
Log likelihood	-1242.4	-337.93	-487.256	-202.764
Akaike AIC	5.017	5.528	4.904	4.067
Schwarz SC	5.324	6.557	5.116	4.674
Mean dependent	2.307	2.514	2.18	1.642
S.D. dependent	3.358	4.626	2.865	1.99

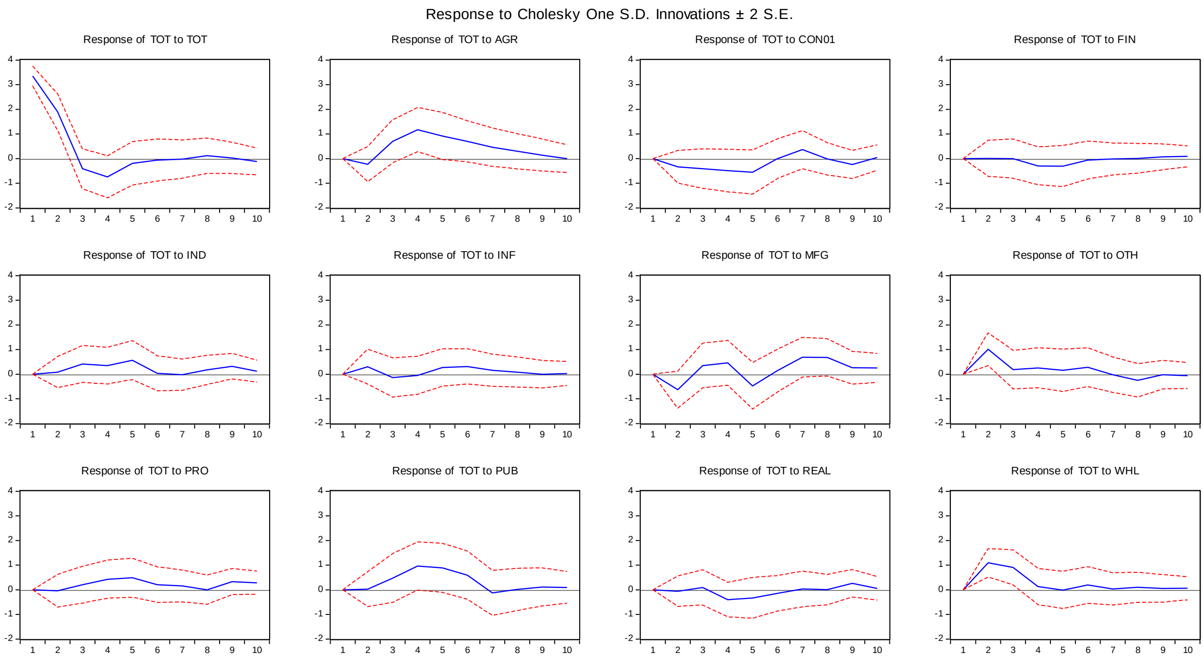
Figure 1 shows that one standard deviation shock to the sector growths of Construction, Finance, Information, Other Services, Professional, Scientific, Support services, public administration, defense, education, health, social work, Real estate sector and wholesale, retail trade, repairs, transport has a positive effect on total growth. On the other hand, the effect of Agriculture, Industry and Manufacturing sectors is negative.

Figure 1: Impulse Response Analysis Results Obtained for Panel VAR Model



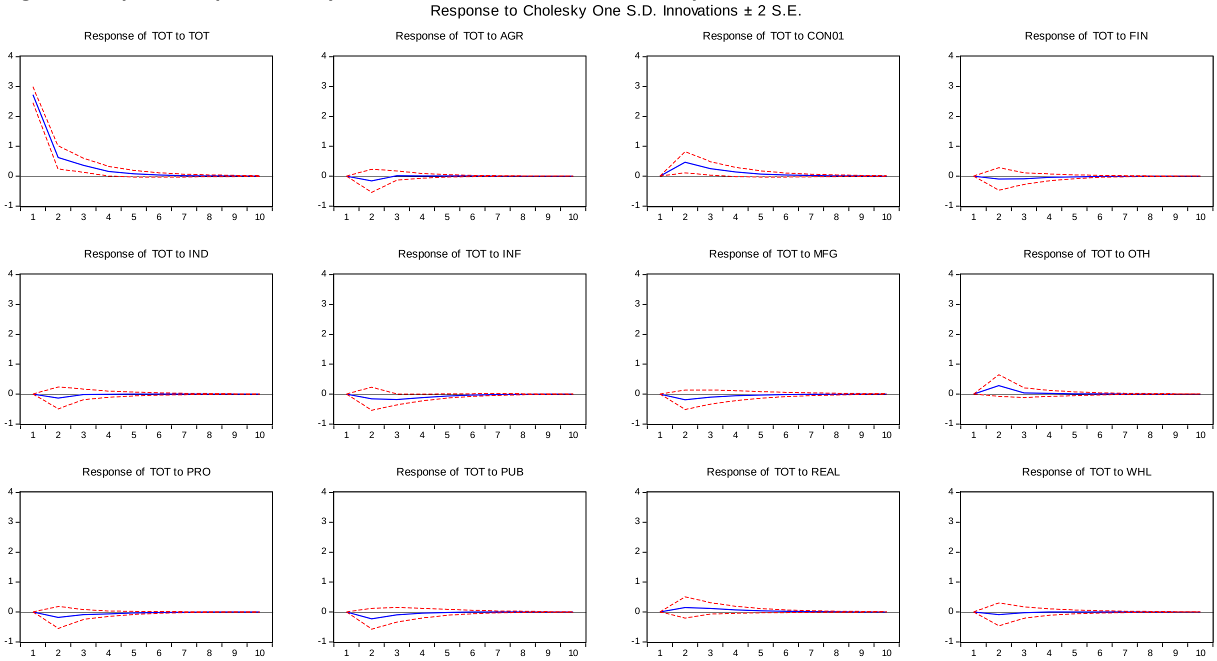
The impulse-response graph results of the first group were examined; in terms of the countries in this group, one standard deviation shock to the sector growths of Finance, Information, Other Services, Industry, Professional, Scientific, Support services and Wholesale, retail trade, repairs, transport have a positive effect on total growth. Furthermore, the effect of Agriculture, Construction, Manufacturing, Professional, Scientific, Support services and Real estate sector sectors have negative effect.

Figure 2: Impulse Response Analysis Results for PVAR Model on Group 1 Countries



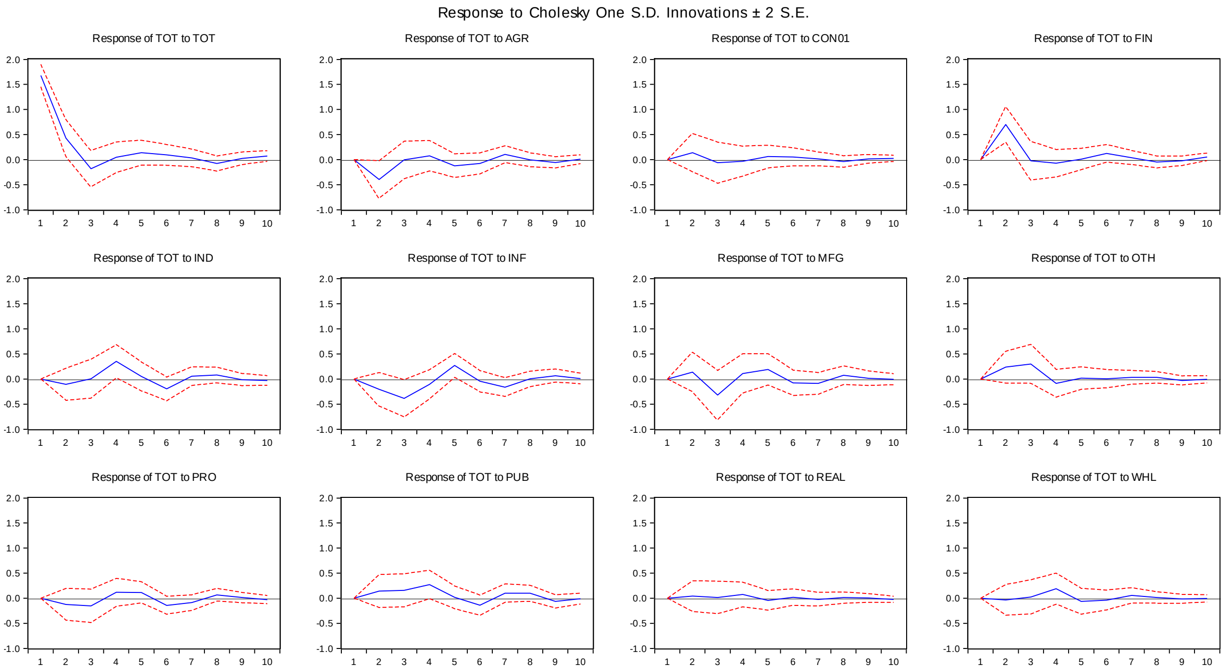
The impulse-response analysis results of the Group 2 of the countries are examined, one standard deviation shock to the sector growths of Construction, Other Services and Real estate sector have a positive effect on total growth for the countries in this group. The effect of Agriculture, Finance, Industry, Information, Manufacturing, Professional, Scientific, Support services, public administration, defense, education, health, social work and Wholesale, retail trade, repairs, transport sectors have negative effect.

Figure 3: Impulse Response Analysis Results for PVAR Model on Group 2 Countries



The impulse-response graph results for the group 3 countries, one standard deviation shock to the sector growths of Construction, Manufacturing, Other Services Public administration, defense, education, health, social work, and real estate sector have a positive effect on total growth. Also, the effect of Agriculture, Finance, Industry, Information, Professional, Scientific, Support services and Wholesale, retail trade, repairs, transport sectors have negative effect.

Figure 4: Impulse Response Analysis Results for PVAR Model on Group 3 Countries



According to the findings, the direction of the effect of sector growth on the total growth, the maximum value, the period when the maximum value was reached, and the period in which the effect changes sign is summarized in Table 5 and 6 for all models.

The change in direction of the response of total growth to shocks caused by sector growth was examined in terms of groups.

Impulse response analysis shows the effect of one standard deviation shock on each variable. The short-term impact of each sector's shock on total growth is shown in this analysis. To reveal the general structure of these effects, the above tables (5 and 6) is prepared. The table shows the direction, size, and periodic length of the impact of the shock in each sector on total growth.

For example, when the agricultural sector is analyzed in terms of both the OECD group and sub-groups, it is seen that the effect of a shock in the sector is negative on total growth. As of the period examined, this situation is within the expectation of the agricultural sector. When the other sectors are analyzed, it is determined that sector effects differ according to country groups.

For instance, the construction sector points to a positive impact on growth in the model in the OECD group. It is understood that for the countries in Group 2 and Group 3, the shock on the construction sector has a positive effect on those countries. Contrary it is seen that Group 1 countries will not be positively affected by an effect the construction sector like other countries. Another importance of this result is that such results can be obtained by using goal programming and clustering method.

Observing which sectors are affected in the short term for each group is possible. In Group 1, the impact of a shock in the Construction, Industry, Other Services and Public administration, defense, education, health, and social work sectors disappear completely after 7 periods. The effects of the shocks in these sectors are not easily absorbed by the system. Namely, they indicate that positive effects continue in the relatively long term. Consequently, the results in this table produce results that guide policymakers.

Table 5: Summary Table of Impulse-Response Analysis for "OECD Group and Group1"

	OECD GROUP				GROUP 1			
Period	**Sign of response**	**Max. value**	**Effect maximization occurs in period**	**Effect disappears**	**Sign of response**	**Max. value**	**Effect maximization occurs in period**	**Effect disappears**
AGR	-	-0.15	2	3	-	-0.23	2	3
CON	+	0.20	2	4	-	-0.55	5	7
FIN	+	0.18	2	3	+	0.01	2	3
IND	-	-0.31	2	3	+	0.57	5	7
INF	+	0.06	2	3	+	0.30	2	3
MFG	-	-0.27	5	9	-	-0.63	2	3
OTH	+	0.68	2	6	+	0.28	6	7
PRO	+	0.15	3	8	-	-0.05	2	3
PUB	+	0.32	3	8	+	0.96	4	7
REAL	+	0.02	2	3	-	-0.06	2	3
WHL	+	0.32	4	10	+	1.Eyl	2	5

Table 6: **Summary Table of Impulse-Response Analysis for "Group 2 and Group 3"**

	GROUP 2				GROUP 3			
Period	Sign of response	Max. value	Effect maximization occurs in period	Effect disappears	Sign of response	Max. value	Effect maximization occurs in period	Effect disappears
AGR	-	-0.16	2	3	-	-0.40	2	7
CON	+	0.46	2	4	+	0.14	2	3
FIN	-	-0.10	2	4	+	0.70	2	3
IND	-	-0.13	2	4	-	-0.11	2	3
INF	-	-0.18	3	6	-	-0.39	3	5
MFG	-	-0.19	2	5	+	0.14	2	3
OTH	+	0.28	2	4	+	0.30	3	4
PRO	-	-0.18	2	5	-	-0.15	3	4
PUB	-	-0.23	2	7	+	0.27	4	6
REAL	+	0.15	2	5	+	0.07	4	5
WHL	-	-0.08	2	4	-	-0.03	2	3

5. CONCLUSION AND POLICY IMPLICATIONS

The study examined the growth dynamics of 34 OECD member countries between 2000 and 2017. Eleven sector data for each country were taken into account to understand which sector originated the growth characteristics of the countries.

Countries analyzed in terms of the contribution of sectoral growth rates to the growth rate of the country were divided into groups by cluster analysis. It is determined that the countries grouped in terms of the contribution of sectors to growth are divided into 5 groups. The first group has 10 member countries. The second group has 12 countries, and the third group has 7 countries, the fourth group has 4 countries and only 1 country belongs to the fifth group. It is constructed that the third group of the 12 countries belongs to the third fourth and fifth groups.

The countries in group 1 are Estonia, Turkey, Greece, Italy, Poland, Portugal, Lithuania, Latvia, Slovakia, and Slovenia. The countries in group 2 are Australia, Belgium, the Czech Republic, Germany, Denmark, Hungary, Ireland, Mexico, Netherlands, Norway, Sweden, and New Zealand. The countries in group 3 are Austria, Spain, Finland, France, the Republic of Korea, Luxembourg, Switzerland, the USA, Israel, Costa Rica, the United Kingdom, and Japan.

Based on the factor sizes obtained for the first group of countries, it has been determined that the most important dynamics of growth with an average of 26% is the Wholesale, retail trade, repairs, and transport sector (WHL). The sectors that have an impact on growth after this sector are Industry (IND) with 20%, and public administration, defense, education, health, and social work (PUB) with 16%.

Based on the factor sizes obtained for the second group of countries, the most important dynamics of growth, with an average of 23%, were IND. The sectors that have an impact on growth after this sector are Wholesale, retail trade, repairs, and transport, with 16% Public administration, defense, education, health, and social work sectors.

The countries in the third group are mixed groups. Based on the factor sizes obtained, it has been determined that the most important dynamics of growth with an average of 18% are wholesale, retail trade, repairs, and transport. The sectors that have an impact on growth after this sector are public administration, defense, education, health, social work, and Industry with 13.5%.

The whole group of all OECD countries is investigated for this study, it is determined that the most important dynamics of growth with an average of 21%, based on factor sizes, are Wholesale, retail trade, repairs, and transport. Following this sector, the sectors that have an impact on growth are Industry with 19%, and Public administration, defense, education, health, and social work with 16%.

As can be seen from this study, the first three sectors of growth are the same for groups, but for 3 groups, the difference is in their order. This difference is also important for getting the correct information from the econometric analysis.

A similar situation was obtained from the Panel VAR model estimation results. As a result of this analysis, it was observed that the effects of shocks occurring in the sectors in each group differ.

The results of the panel cross-section dependency analysis show that the null hypothesis, which expresses cross-section independence, failed to reject for the OECD countries' group and group 3 but rejected for group 1 and group 2. Namely, there is no cross-sectional dependence between the OECD countries' group and group 3 which are the groups that it is hybrid.

As a result of the examination of these groups, the VAR analysis also provides information on how much each sector is affected by other sectors. From this point of view, it will be appropriate to make investment planning and resource allocation by using the impulse response analysis and variance decomposition analysis of the group which countries can take into consideration in terms of the interaction of the sector structures.

It can be also concluded that countries that have similar sectoral structures can analyze the growth, but it is important to form homogeneous groups while doing this analysis. For this reason, another essential suggestion offered based on the study is the use of the FGP methodology in the analysis method.

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Appendix: FGP Problem Established with the Hannan Approach for Australia as an Example

$$Z_{\max} = \lambda$$

Subject to

$$3.8356x_1 - 14.2992x_2 + 1.3067x_3 + 3.4144x_4 + 3.6893x_5 + 2.1214x_6 + 5.0612x_7 + 9.8686x_8 + 3.0637x_9 + 2.4834x_{10} + 2.6112x_{11} + 0.2293n_{20000} - 0.2293p_{2000} = 2.2937$$
$$3.1543x_1 + 12.4538x_2 + 6.4553x_3 + 1.9964x_4 + 3.2541x_5 + 2.7470x_6 + 1.0043x_7 + 5.3092x_8 + 4.3994x_9 + 1.8632x_{10} + 3.5492x_{11} + 0.3982n_{2001} - 0.3982p_{2001} = 3.9827$$
$$-21.6022x_1 + 16.3570x_2 + 3.2945x_3 + 2.3293x_4 + 6.1478x_5 + 3.8547x_6 + 4.4586x_7 + 1.2508x_8 + 1.7590x_9 + 2.8641x_{10} + 4.7911x_{11} + 0.2789n_{2002} - 0.2789p_{2002} = 2.7898$$
$$25.5142x_1 + 8.2290x_2 + 6.5155x_3 - 0.0179x_4 + 4.2860x_5 + 1.2731x_6 + 5.2617x_7 + 3.1326x_8 + 2.8150x_9 + 2.3053x_{10} + 4.6558x_{11} + 0.4089n_{2003} - 0.4089p_{2003} = 4.0895$$
$$4.2838x_1 + 4.9107x_2 + 5.0847x_3 + 0.9163x_4 + 2.7916x_5 - 0.9844x_6 + 0.4215x_7 + 2.5663x_8 + 3.3837x_9 + 3.8417x_{10} + 4.8621x_{11} + 0.3314n_{2004} - 0.3314p_{2004} = 3.3144$$
$$2.8568x_1 + 6.4504x_2 + 4.5905x_3 + 0.3574x_4 + 3.9336x_5 - 0.6411x_6 + 0.1188x_7 + 4.7053x_8 + 2.7080x_9 + 3.3220x_{10} + 2.3977x_{11} + 0.2839n_{2005} - 0.2839p_{2005} = 2.8393$$
$$-15.0389x_1 + 5.7011x_2 + 10.0584x_3 + 4.4853x_4 + 6.5809x_5 + 2.0657x_6 + 3.9875x_7 + 3.8700x_8 + 3.8450x_9 + 0.0419x_{10} + 4.6830x_{11} + 0.3908n_{2006} - 0.3908p_{2006} = 3.9081$$
$$8.0938x_1 + 7.1979x_2 + 5.1602x_3 + 3.1634x_4 + 6.0903x_5 + 3.9784x_6 + 2.0639x_7 + 4.6670x_8 + 2.6602x_9 + 0.6004x_{10} + 4.4724x_{11} + 0.3848n_{2007} - 0.3848p_{2007} = 3.8482$$
$$17.0795x_1 + 4.4493x_2 + 0.1313x_3 - 0.5762x_4 + 1.3542x_5 - 5.1304x_6 + 4.5319x_7 + 1.2222x_8 + 5.4873x_9 + 3.2430x_{10} - 0.1109x_{11} + 0.2188n_{2008} - 0.2188p_{2008} = 2.1886$$
$$-0.7460x_1 + 0.5807x_2 + 0.4932x_3 + 3.9906x_4 + 1.9905x_5 + 0.3963x_6 + 0.1415x_7 + 4.1530x_8 + 2.9236x_9 + 0.7009x_{10} + 1.7118x_{11} + 0.2226n_{2009} - 0.2226p_{2009} = 2.2261$$
$$3.4663x_1 + 2.9531x_2 + 2.0220x_3 + 0.7257x_4 + 3.3297x_5 - 0.2535x_6 + 1.6870x_7 + 7.4626x_8 + 2.2326x_9 + 2.5119x_{10} + 1.6813x_{11} + 0.2510n_{2010} - 0.2510p_{2010} = 2.5108$$
$$0.9736x_1 + 11.3163x_2 + 5.0785x_3 + 3.8949x_4 + 1.1848x_5 + 0.9068x_6 + 3.9035x_7 + 2.9385x_8 + 2.6075x_9 + 2.7328x_{10} + 4.3774x_{11} + 0.4063n_{2011} - 0.4063p_{2011} = 4.0632$$
$$-0.7280x_1 + 3.5476x_2 + 3.2650x_3 + 3.4311x_4 - 0.1386x_5 - 3.2176x_6 - 2.1438x_7 + 2.7677x_8 + 2.5790x_9 + 2.7418x_{10} + 2.9435x_{11} + 0.2688n_{2012} - 0.2688p_{2012} = 2.6882$$
$$1.1444x_1 + 4.4825x_2 + 2.3945x_3 + 3.9155x_4 + 4.0982x_5 - 1.0780x_6 + 4.0388x_7 + 1.9056x_8 + 3.6771x_9 + 2.4672x_{10} + 0.2033x_{11} + 0.2719n_{2013} - 0.2719p_{2013} = 2.7192$$
$$1.4266x_1 - 2.5636x_2 + 4.7743x_3 + 3.2787x_4 + 7.2181x_5 - 1.5880x_6 + 1.9389x_7 + 2.1287x_8 + 2.9903x_9 + 1.4369x_{10} + 2.4298x_{11} + 0.2403n_{2014} - 0.2403p_{2014} = 2.4034$$
$$-7.9012x_1 - 1.2279x_2 + 4.9423x_3 + 2.0692x_4 + 7.2955x_5 - 2.2271x_6 + 1.8499x_7 + 3.1726x_8 + 3.5274x_9 + 3.6257x_{10} + 3.0233x_{11} + 0.2660n_{2015} - 0.2660p_{2015} = 2.6607$$
$$9.5979x_1 - 3.2326x_2 + 3.4074x_3 + 0.2720x_4 + 3.7840x_5 - 1.0337x_6 + 1.2529x_7 + 5.2286x_8 + 2.5977x_9 + 2.5178x_{10} + 3.1131x_{11} + 0.2345n_{2016} - 0.2345p_{2016} = 2.3454$$
$$-5.0514x_1 + 5.0970x_2 + 3.4323x_3 + 2.7887x_4 + 2.7300x_5 + 3.0492x_6 + 3.4388x_7 + 4.2430x_8 + 3.1680x_9 + 2.0194x_{10} + 1.7269x_{11} + 0.2778n_{2017} - 0.2778p_{2017} = 2.7786$$

$$\begin{array}{lll}
\lambda + n_{2000} + p_{2000} \le 1 & \lambda + n_{2006} + p_{2006} \le 1 & \lambda + n_{2012} + p_{2012} \le 1 \\
\lambda + n_{2001} + p_{2001} \le 1 & \lambda + n_{2007} + p_{2007} \le 1 & \lambda + n_{2013} + p_{2013} \le 1 \\
\lambda + n_{2002} + p_{2002} \le 1 & \lambda + n_{2008} + p_{2008} \le 1 & \lambda + n_{2014} + p_{2014} \le 1 \\
\lambda + n_{2003} + p_{2003} \le 1 & \lambda + n_{2009} + p_{2009} \le 1 & \lambda + n_{2015} + p_{2015} \le 1 \\
\lambda + n_{2004} + p_{2004} \le 1 & \lambda + n_{2010} + p_{2010} \le 1 & \lambda + n_{2016} + p_{2016} \le 1 \\
\lambda + n_{2005} + p_{2005} \le 1 & \lambda + n_{2011} + p_{2011} \le 1 & \lambda + n_{2017} + p_{2017} \le 1
\end{array}$$

$$\begin{array}{ll}
x_i \ge 0 & i = 1, 2, .., 11 \\
n_j, p_j \ge 0 & j = 2000, 2001, ..., 2017 \\
\lambda \ge 0 &
\end{array}$$

Appendix 2: Impacts of Sectoral Growth Rates of Countries on Growth Rate

STATE	AGR	CON	FIN	IND	INF	MFG	OTH	PRO	PUB	REAL	WHL
AUS	0,0364	0,0715	0,1307	0,2311	0,0057	0,0000	0,0101	0,1161	0,1459	0,1179	0,1290
AUT	0,0230	0,0672	0,0537	0,2034	0,0235	0,0233	0,0000	0,1102	0,1200	0,0823	0,2037
BEL	0,0045	0,0555	0,0579	0,1936	0,0597	0,0000	0,0416	0,1159	0,1386	0,0805	0,1964
CHE	0,0066	0,0389	0,1191	0,1191	0,0448	0,0935	0,0228	0,0927	0,1335	0,0686	0,2174
CRI	0,1071	0,0284	0,0463	0,1376	0,0226	0,0000	0,0945	0,0701	0,1007	0,1331	0,2243
CZE	0,0256	0,0546	0,0380	0,2747	0,0489	0,0350	0,0221	0,0766	0,1158	0,0739	0,1830
DEU	0,0121	0,0494	0,0480	0,2279	0,0480	0,0193	0,0068	0,1160	0,1779	0,0879	0,1741
DNK	0,0127	0,0626	0,0587	0,1886	0,0326	0,0112	0,0691	0,0690	0,2170	0,1105	0,2066
ESP	0,0371	0,0791	0,0562	0,1616	0,0571	0,0265	0,0443	0,0731	0,1324	0,0791	0,2063
EST	0,0349	0,0745	0,0457	0,1945	0,0674	0,0000	0,0402	0,0480	0,2050	0,0856	0,2328
FIN	0,0165	0,0658	0,0277	0,2666	0,0568	0,0000	0,0000	0,1058	0,2982	0,0856	0,1391
FRA	0,0172	0,0590	0,0401	0,1563	0,0569	0,0000	0,0358	0,1373	0,2036	0,1073	0,1622
GBR	0,0165	0,0345	0,0900	0,1680	0,0503	0,0000	0,0416	0,1073	0,0733	0,1992	0,1926
GRC	0,0130	0,0692	0,0000	0,0895	0,0155	0,0000	0,0978	0,0203	0,1388	0,0996	0,3250
HUN	0,0457	0,0527	0,0307	0,2693	0,0440	0,0000	0,0108	0,0941	0,1667	0,0728	0,1624
IRL	0,0221	0,0403	0,0808	0,2519	0,0835	0,0000	0,0000	0,0747	0,1597	0,0994	0,1965
ISR	0,0070	0,0999	0,0700	0,1495	0,0562	0,0000	0,0473	0,0480	0,1525	0,2461	0,1166
ITA	0,0262	0,0481	0,0570	0,2022	0,0353	0,0000	0,0355	0,0950	0,1940	0,1112	0,2088
JPN	0,0148	0,0681	0,0585	0,0239	0,0785	0,2119	0,0328	0,0917	0,0000	0,0163	0,1550
KOR	0,0279	0,0578	0,0697	0,0644	0,0471	0,2183	0,0092	0,0352	0,1989	0,0916	0,1927
LTU	0,0403	0,0862	0,0153	0,1960	0,0627	0,0000	0,0153	0,0439	0,0909	0,0668	0,3096
LUX	0,0100	0,0705	0,2408	0,0995	0,0562	0,0000	0,0473	0,0823	0,1112	0,0960	0,1880
LVA	0,0581	0,0637	0,0530	0,1261	0,0290	0,0000	0,0573	0,0392	0,2364	0,0747	0,2707
MEX	0,0488	0,0657	0,0205	0,1914	0,0335	0,0000	0,0570	0,0551	0,1273	0,0094	0,3293
NLD	0,0153	0,0577	0,0908	0,1789	0,0509	0,0000	0,0000	0,1320	0,1712	0,0514	0,2011
NOR	0,0125	0,0619	0,0210	0,3792	0,0426	0,0019	0,0189	0,0494	0,2046	0,0749	0,1655
POL	0,0350	0,0897	0,0417	0,2485	0,0415	0,0000	0,0319	0,0448	0,1411	0,0525	0,2720
PRT	0,0192	0,0749	0,0448	0,1621	0,0369	0,0000	0,0431	0,0755	0,1697	0,0953	0,2329
SVK	0,0250	0,0671	0,0199	0,2597	0,0753	0,0000	0,0184	0,0715	0,0944	0,0827	0,2408
SVN	0,0305	0,0875	0,0192	0,2674	0,0396	0,0000	0,0300	0,0688	0,2084	0,1018	0,1906
SWE	0,0059	0,0851	0,0467	0,2083	0,0602	0,0000	0,0000	0,0596	0,1842	0,0983	0,2472
TUR	0,0783	0,0472	0,0239	0,2649	0,0268	0,0000	0,0000	0,0464	0,1852	0,0722	0,2670
USA	0,0129	0,0450	0,0778	0,0795	0,0760	0,0887	0,0469	0,1410	0,1699	0,0814	0,1327
NZL	0,0600	0,0512	0,0648	0,1955	0,0443	0,0000	0,0252	0,0934	0,1599	0,1115	0,1803

Appendix 3: Countries Grouped by Impact Values

Groups	Countries
Group 1	Estonia, Turkey, Greece, Italy, Poland, Portugal, Lithuania, Latvia, Slovakia, Slovenia
Group 2	Australia, Belgium, Czech Republic, Germany, Denmark, Hungary, Ireland, Mexico, Netherlands, Norway, Sweden, New Zealand,
Group 3	Austria, Spain, Finland, France, Republic of Korea, Luxembourg, Switzerland, USA, Israel, Costa Rica, United Kingdom, Japan

Appendix 4: Panel VAR Model Appropriate Lag Length

	Lag	LogL	LR	FPE	AIC	SC	HQ
OECD group	3	-13688.1	324.6247	9.63e+12*	63.94594*	68.05576	65.56697
Group 1	4	-3734.23	223.3443*	1.96e+14*	66.49585	79.46593	71.76603
Group 2	1	-4586.87	361.3713	4.17e+11*	60.80604*	63.8559	62.04476
Group 3	2	-2661.96	249.6739*	5.77e+09*	56.41825*	64.001	59.49093

Appendix 5: Inverse Roots Graphs