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MEASURING THE EFFECT OF ENTRY INTO THE EUROZONE ON ECONOMIC GROWTH – DATA STORYTELLING USING CLUSTERING AND ANFIS

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Abstract. The aim of this paper is to examine the impact of a country's entry into the monetary union on its economic variables *growth rate of real GDP* as well as on *GDP per capita growth* for the period from 2010 to 2020. The clustering method and the ANFIS method were used in the data analysis. A total of two cluster analyses were performed. The first cluster includes countries that joined the EU in 2004 and became EZ members by 2010. The second cluster refers to those countries that joined the EU in 2004 but are not yet members of the EZ. For the first individual cluster analysis two models were analysed and for the second individual cluster three models were analysed using the ANFIS method. As expected, the results showed that GDP growth is connected with trade, inflation and gross investments in fixed capital in the observed countries, while GDP per capita is connected with unemployment, interest rates and public debt. With regard to GDP growth, the difference between countries that are in the eurozone and those that are not is not significant, which is in line with other studies.

Keywords: European Union, European integration, financial integration, Eurozone, clustering, ANFIS method.

JEL Classification: F15, F36, F43, F45.

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1. Introduction

Financial integration creates preconditions for sustainable growth of the standard of living as the ultimate economic goal. In order for countries to enter the monetary union and be financially integrated, they must meet certain convergence criteria related to price stability, sound and sustainable public finances, long-term interest rate and exchange rate stability (Suljić et al., 2022). Once the countries meet the convergence criteria and enter the eurozone, they must also adhere to the common rules of sustainable public finances in the future. Public debt should not exceed 60% of GDP and the fiscal deficit should not exceed 3% of GDP. However, it is worth pointing out that in addition to the positive aspects of financial integration, there are also negative ones such as the impossibility of using one's own national monetary policy and a short-term and slight increase in the price level (European Commission, 2017). Countries differ in their economic structure, their development is different, institutional and

informal norms of behavior differ, so it is logical to expect that a single monetary policy will not suit everyone equally (Baimbridge et al., 2000; Tomas Žiković, 2020).

A single currency enables easier price comparisons between countries, which encourages competition and results in greater price stability. Greater price stability enables lower interest rates, which encourages investments. Without currency risk, business operations are cheaper, more transparent and safer, which affects the economic stability of countries. Economic stability enables sustainable economic growth, the creation of new jobs, low and stable inflation, which ultimately contributes to the growth of the standard of living (Labanauskaitė et al., 2021).

In addition to being an economic formation, the European Monetary Union (EMU) is also a political one, because the European Commission, by expanding the common currency area, further strengthens the common space, achieving its political goal of stability, while on the other hand, many economists warn that Europe is not an optimal currency area, which can have negative consequences for the economy of the union (for example, Mongelli, 2002). An optimal currency area refers to a unique geographical area of one or more currencies whose exchange rates are irrevocably fixed. According to Bilas (2005) and Ozdeser (2020), there are several basic criteria for an optimal currency area, such as mobility of production factors, diversification of production and consumption, similar preferences of unique monetary policy, fiscal transfers and political integration.

The aim of this paper is to examine the impact of joining the monetary union on the growth rate of real GDP and also on GDP per capita growth rate for the observed groups of countries using the ANFIS method. Independent variables that have an impact on real GDP growth rate and GDP per capita growth rate were selected based on previous studies on the economic impact of joining the monetary union. In order to be able to compare the collective effects of joining the monetary union in relation to the group of countries that are not members of the monetary union, it is necessary to take a certain common time period of observation into the analysis so that the results are comparable.

The problem of choosing a single time period is that a larger or smaller number of countries joined the European Union (EU) together in a certain year – the enlargement cycle, but they did not join the monetary union at the same time. For this reason, the period from 2010 to 2020 was taken into analysis for the countries that became EU members in 2004. Then 10 new countries became part of the EU, which is the last major recent enlargement. Since joining the EU in 2004, Slovenia became a member of the Euro zone (EZ) in 2007, Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014 and Lithuania in 2015, and finally, Croatia in 2023.

In order to have a consistently longer time period in which a larger number of countries became part of the monetary union for comparison, the period from 2010 to 2020 – the latest available data – was taken into consideration. In the data analysis, the clustering method was used, which served to create a model for further analysis. A total of two cluster analyses were performed. The first cluster includes countries that joined the EU in 2004 and became EZ members by 2010 – Slovenia, Cyprus, Malta, Slovakia (Estonia, which became a member of the monetary union in 2011, was also included in the analysis). The second cluster refers to those countries that joined the EU in 2004 but are not yet members of the EZ – the Czech

Republic, Hungary and Poland. From each individual cluster analysis, two models were analyzed using the ANFIS method.

In the introduction part authors explain the significance of studying the impact of eurozone entry on economic variables. After that the literature review has been conducted that presents prior research on the relationship between eurozone entry and economic growth. In this part the findings of previous studies, as well as gaps in the literature that this research aims to address, have been highlighted. The dataset and methodology part describes the data sources and variables used in the analysis, emphasizing the relevance of the selected time frame (2010–2020) and explaining how data were cleaned and prepared for analysis, ensuring data quality. In the result part authors presented cluster analysis, focusing on countries that joined the EU in 2004 but were not yet EC members and models analyzed using the ANFIS method. In the discussion part the results of the clustering and ANFIS analyses in the context of the research objective have been interpreted. In the conclusion authors summarize the key findings of the study, including whether entry into the eurozone significantly affects GDP growth and GDP per capita growth.

In this structured approach, the authors have effectively examined their research objective by utilizing clustering and ANFIS analysis to explore the relationship between eurozone entry and economic growth, providing valuable insights into the factors that influence GDP growth and GDP per capita growth in the examined countries.

2. Literature review

According to the neoclassical theory, to have sustainable economic growth, we need continuous technological changes that enable higher productivity of production factors, while the new endogenous theory of growth – the "theory of integration" claims that the transfer of knowledge between countries as a result of integration should lead to an increase in higher long-term GDP growth rates per capita. The market expansion enables long-term economic growth rates through innovation. Namely, for the sake of greater competitiveness and level of knowledge, companies are forced to invest in research and development, which will result in continuous innovation. The theory of integration is based on the so-called scale effect, which can be explained by the fact that the increase in the market intensifies the mutual transfer of knowledge and the efficiency of the research sector. In addition, market expansion gives companies an incentive to invest in R&D because they will be able to sell their new products to more people. This guarantees a faster return and higher profits (Vanhoudt, 1999). Endogenous integration theory can be seen as a sub-theory of neoclassical growth theory, which claims that the source of technological progress is the expansion of the market due to the scale effect. By expanding the market, investments in research and development are encouraged, the market becomes more competitive and efficient through better mobility of production factors (Morić Milovanović et al., 2021). The effect of growth based only on integration is the subject of numerous studies.

If the integration itself leads to continuously high GDP growth rates, this should be an indicator of the continuous growth rate of technological changes as a result of efficient exchange of knowledge and investment in R&D. If this is not the case, then empirical research

should indicate that there are no significant differences from integration. Better mobility of production factors is necessary for the exchange of knowledge and is one of the factors of an optimal currency area (Rivera Batiz & Romer, 1991; Morić Milovanović, 2023). Škare and Tomić (2015) state that economic growth is one of the most important issue in economics, so the research which deal with it are of special importance. The validity of various growth theories should be tested with empirical evidence while Tomić and Demanuele (2017) emphasize that monetary integration is complicated issue which requires continuous scientific verification.

In their works, the authors most often use panel regression analysis to examine the impact of integration on economic growth. Countries in the EU are compared with those outside the EU, as well as those countries that are in the eurozone are compared to those countries that are not members of the monetary union. The dependent variable in the models is the *economic growth rate*, represented by the *GDP per capita growth rate* or expressed in general terms as *growth rate of real GDP*. To examine the impact of integrations, dummy variables are used in order to determine a statistically significant impact of integrations. The following are used as independent variables: trade, inflation, investments, interest rate, unemployment rate, public debt, etc.

For example, Crespo Cuaresma et al. (2008) observed the period from 1960–1998 and concluded that there was a significant positive impact of EU membership on economic growth. The longer countries have been in the EU, the more benefits they gain from membership in the form of an increase in standard of living. A significant positive impact of EU membership on economic growth was also found by the authors Gehringer (2013) for the period from 1990 to 2007 and Konig (2015) for the period from 1993 to 2012, whereat that they also found that membership in the eurozone did not contribute to the increase in the standard of living of the observed countries. As opposed to them, Conti (2014) gets exactly the opposite conclusion related to membership in the eurozone. He observed the period from 1990 to 2010 and concluded that the euro had a positive impact on the growth of standard of living and productivity by about 4%. The impact of the euro on the standard of living was less in those countries that had a high percentage of public debt.

More recent research on the impact of economic integration on economic growth, conducted by Georgiou (2020) for the period 1990–2018, indicates that membership in the EU and eurozone did not contribute statistically significantly to the growth of the standard of living. At the same time, it is worth noting that membership in the EU during the crisis was statistically significant and this had a negative impact on the growth of the standard of living. During the crisis, membership in the eurozone did not have a statistically significant impact, despite assumptions in the literature that claim that the euro is a significant weight in the recovery of member states. The use of a single monetary policy and fiscal restrictions do not suit all countries, but this was not a significant negative factor in the light of the crisis.

Badinger (2005) used the dynamic growth framework method in his research and found out that European integration from 1950 to 2000 led to an increase in GDP per capita of the EU economy by approximately 20%, whereby he rejected the hypothesis of permanent growth of the EU economy due to integration, as advocated by the endogenous theory. In addition, Fernandez and Garcia-Perea (2015) investigated the impact of membership in the eurozone on permanent and sustainable economic growth using the synthetic control

method since the establishment of the eurozone until 2014 and concluded that there was no expected lasting increase. The countries achieve a neutral effect from the membership in the eurozone because the initial positive effects from the eurozone disappeared due to the global crisis. The studies of the aforementioned authors do not find evidence for the validity of the endogenous theory of integration. The synthetic control method was also used by Garoupa and Spruk (2020), who state that membership in the EU increases the standard of living by an average of 12%. The individual analysis of countries indicates that there are significant differences in the increase of the standard of living between countries.

Campos et al. (2019) used the synthetic control method to investigate the impact of countries joining the European Union on their economic growth and workforce productivity. They analyzed the countries that joined the EU from 1973 to 2004, and concluded that all countries, except Greece, achieved positive net benefits from the membership. Without European integration, GDP per capita would be approximately 10% lower on average in the first 10 years after joining the EU. Joining the eurozone has a positive impact on increasing the standard of living, while the benefits of membership differ between countries. Countries that implement their structural reforms faster and more efficiently see greater benefits. For this reason, peripheral countries benefit less from European integration.

Mongelli (2002) states that EMU member states that have structural problems cannot meet the conditions of an optimal currency area. The implementation of structural reforms in such countries increases the efficiency and competitiveness of their economies and thus the EMU. At the same time, Petreski (2007) states that the eurozone from its very beginning does not meet al. the conditions of an optimal currency area. Although significant progress is visible, there is still quite a lot of room for improvement. Boitani and Tamborini (2020) advocate a reform of the eurozone that needs common institutions because better rules are not enough to achieve an optimal currency area.

In his work, Dauderstädt (2021) points out that the economic benefits of the single market are obvious for all countries, but these benefits differ greatly between countries. Economic growth is dependent on the quantity and quality of attracted investments and accumulated knowledge, from which countries that later join the processes of European integration benefit the least.

On the other hand, Grabner and Hafele (2020) state that in the short term we can see signs of a convergence process, but that in a longer period of time the existence of core-periphery country relations leads to the widening of the gap in the standard of living. Apart from the individual characteristics of the countries, the reason for the divergence of the country is in the asymmetric of trade structures. Core countries trade with the periphery countries in technologically more complex goods, so the technological exchange is unequal. The benefits of increased trade for the sake of a common currency area are not equal because the technology of the peripheral countries is less developed. Mursa (2014) points out that the greatest benefits from the introduction of the euro are reflected in the stimulation of trade, which has a short-term effect. Shortcomings in the sense of inefficient distribution of capital and labour soon come to light, so underdeveloped countries can hardly catch up with more developed ones.

Garoupa and Spruk (2020) examined the impact of EU membership on the economic growth of the countries in the long term. EU membership is associated with an increase in

GDP per capita although there are significant differences between countries. The founding countries – core countries – benefited the most from European integration (GDP per capita growth by 31%), while other countries mostly had mild and temporary growth or none at all. A significant exception is represented by the Middle Eastern countries that joined the EU in 2004, of which Poland, which achieved a growth of 42%, and the Czech Republic with a growth of 19% in 11 years after the membership, are particularly worth mentioning.

Mion and Ponattu (2019) conclude that the further countries are from the geographic core of the EU, the less they benefit from the single market due to lower market access. Also, those countries that have a lower level of technological equipment have a lower ability to innovate, so they cannot even record greater prosperity. There are large differences in the technological equipment of the countries, and there is a danger of further widening of the gap between the countries.

By checking the literature, it is evident that there is no single conclusion on the impact of European integration on economic growth. This is the result of the aforementioned different methodologies, periods of observation, but also the heterogeneity of the countries. How much a country will benefit from European integration can be explained by the implemented structural reforms, the current technological state, the possibility of attracting investments that will create added value, the acquisition of knowledge, the structure of trade exchange and the geographical distance from the centre of Europe. The closer the EU area gets to the optimal currency area, the more visible the collective effects of financial integration on economic growth will be.

3. Dataset and methodology

In order to be able to observe the collective determinants of economic growth of countries that are members of the EU and those that are also members of the eurozone, it is necessary to take a unique time period into the analysis. The problem that arises is that a greater or lesser number of countries joined the EU in a certain year, but they did not join the monetary union at the same time. If, for example, we had such a case that some countries joined the EU together in a certain year and that a part of them also automatically became members of the monetary union by joining the EU, we could more easily measure the effects of joining the monetary union by comparing them with those countries that did not join the eurozone. This made their comparability difficult, so it was necessary to find such a period of time in which the countries that entered the EU in the same year will also be members of the Eurozone during a certain period.

The founding countries of the European Community in 1957 (EC 6) became members of the eurozone in 1999 (EZ 11), when it was founded. Then they were joined by the other countries that made up the EU 15 until 1995. It took more than 40 years from the founding of the European Community to establish a monetary union. Most countries became members of the monetary union after 2000, with the exception of Denmark, Sweden, Greece (became a member of the EZ in 2001) and the United Kingdom (left the EU in 2020). Due to the impossibility of finding data for all countries before 2000, and only two countries that have not since become members of the EZ – Denmark and Sweden, a comparison of the effects before and after joining the monetary union was not possible for the aforementioned countries.

In this paper, the authors therefore had to focus on the relatively newer EU member states, namely those that became members in 2004, when a large number of new member states were recorded. In 1995, the European Union had 15 members, while in 2004 additional 10 countries joined, so the EU consisted of 25 members. Since their accession in 2004, most countries have become members of the EZ with the exception of the Czech Republic, Hungary and Poland, so it is possible to compare the effects of joining the EZ in relation to those countries that have not yet become members of the EZ.

Since joining the EU in 2004, Slovenia became a member of the EZ in 2007, Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014, Lithuania in 2015 and Croatia in 2023. In order to have a consistent period in which all observed countries that became EU members are also EZ members, 2010 was chosen as the starting year. Therefore, Slovenia, Cyprus, Malta, Slovakia were included in the analysis of EZ member states, and Estonia was added as an exception, which joined the EZ in 2011, but it is of exceptional importance for observing the effects that can serve for further analysis and guidelines for Croatia as a soon-to-be member of the EZ.

The period considered in this paper is from 2010 to 2020, for which two analyses were carried out. The first dataset refers to those countries that joined the EU in 2004 but are not yet members of the EZ – the Czech Republic, Hungary and Poland. The second set includes countries that joined the EU in 2004 and became EZ members until 2010 (with the mentioned exception of Estonia, which became an EZ member in 2011) in order to cover as much of the period since they became EZ member states – Slovenia, Cyprus, Malta, Slovakia and Estonia.

Based on the overview of the literature, the variables that were taken into consideration when examining the impact of joining the EZ are: GDP per capita, GDP growth, Trade (% of GDP), Gross fixed capital formation (% of GDP), Inflation, Interest rate, unemployment rate, and public debt (% of GDP).

GDP per capita indicates the growth rate of the standard of living of a certain country, GDP growth is annual percentage growth rate of real GDP (100 = 2015) and is an indicator of economic activity. Trade is obtained by adding up exports and imports and dividing by GDP (% of GDP) and indicates the volume of trade exchange. Gross fixed capital formation (% of GDP) is an indicator of investments, inflation is measured by annual percentage change in the consumer price index (100 = 2015), interest rate means real long term interest rate as a measure of the price of money, unemployment rate indicates the share of the number of unemployed in the total number of the workforce, and public debt expressed as a % of GDP is an indicator of government indebtedness.

The variables of the most significant interest, that is, those with regard to which the effects are observed, are GDP per capita and GDP growth, while all the remaining previously mentioned variables in the analyses serve as their key empirical determinants.

Annual data for all observed variables were taken from the World Bank database with the exception of public debt expressed as % of GDP whose data were taken from the Eurostat database.

The clustering method using dendrogram and the Adaptive neuro fuzzy inference system (ANFIS) were used in the data analysis.

For the purposes of analysis, all data were standardized beforehand.

A dendrogram was used for the purpose of hierarchical clustering, which served to create a model for further analysis.

ANFIS was chosen for analysis due to its exceptional usefulness in analytics because it integrates fuzzy logic and learning neural networks for the approximation of nonlinear functions (Brlečić Valčić et al., 2022; Brlečić Valčić, 2021). ANFIS can detect the patterns and trends of data without making any assumptions about the stationarity of the data. It is well-suited for predicting non-stationary data series since it does not require the input data to be stationary, making it an effective choice for predicting time series data that might contain non-stationary trends or patterns.

The characteristics of creating the first model for ANFIS analysis are shown in Figure 1.

Basic information about Model 1 can be described as:

- Number of nodes: 78.
- Number of linear parameters: 108.
- Number of nonlinear parameters: 27.
- Total number of parameters: 135.
- Number of training data pairs: 55.
- Number of checking data pairs: 0.
- Number of fuzzy rules: 27.
- Minimal training RMSE = 0.0598025.

The characteristics of the creation of the second model for analysis by ANFIS are shown in Figure 2.

Basic information about Model 2 can be described as:

- Number of nodes: 78.
- Number of linear parameters: 108.
- Number of nonlinear parameters: 27.
- Total number of parameters: 135.
- Number of training data pairs: 55.
- Number of checking data pairs: 0.
- Number of fuzzy rules: 27.
- Minimal training RMSE = 0.0117545.

The characteristics of the creation of the third model for analysis by ANFIS are shown in Figure 3.

Basic information about Model 3 can be described as:

- Number of nodes: 78.
- Number of linear parameters: 108.
- Number of nonlinear parameters: 27.
- Total number of parameters: 135.
- Number of training data pairs: 33.
- Number of checking data pairs: 0.
- Number of fuzzy rules: 27.
- Minimal training RMSE = 0.00188549.

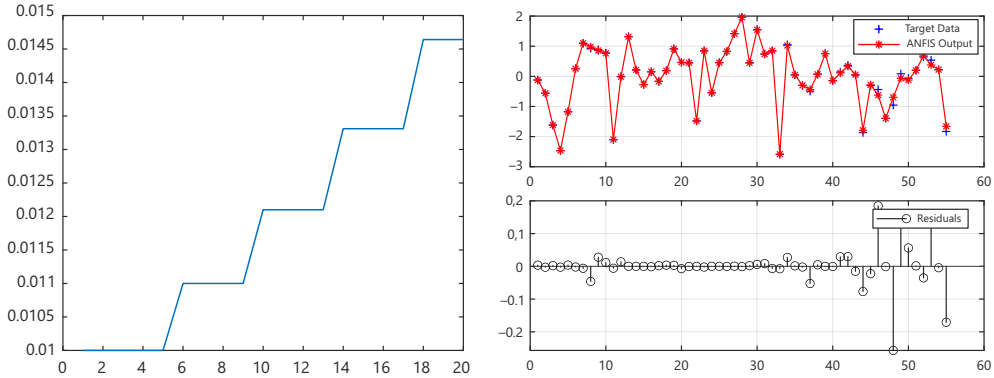

Figure 1. Characteristics of ANFIS model 1
(source: created by the authors in the Matlab software package, 2023)

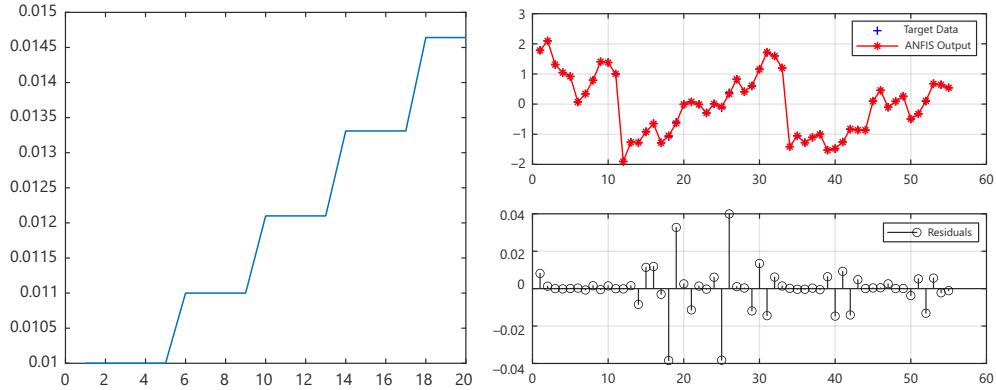

Figure 2. Characteristics of ANFIS model 2
(source: created by the authors in the Matlab software package, 2023)

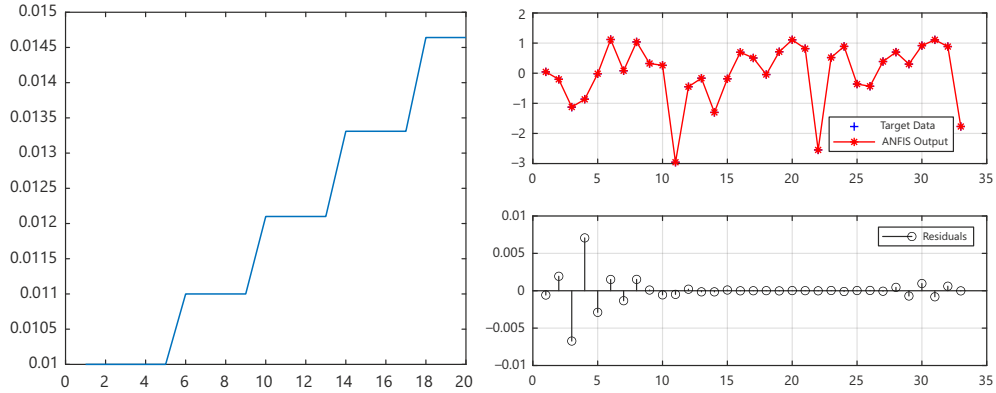

Figure 3. Characteristics of ANFIS model 3
(source: created by the authors in the Matlab software package, 2023)

The characteristics of the creation of the fourth model for analysis by ANFIS are shown in Figure 4.

Basic information about Model 4 can be described as:

- Number of nodes: 35.
- Number of linear parameters: 27.
- Number of nonlinear parameters: 18.
- Total number of parameters: 45.
- Number of training data pairs: 33.
- Number of checking data pairs: 0.
- Number of fuzzy rules: 9.
- Minimal training RMSE = 0.629292.

The characteristics of the creation of the fifth model for analysis by ANFIS are shown in Figure 5.

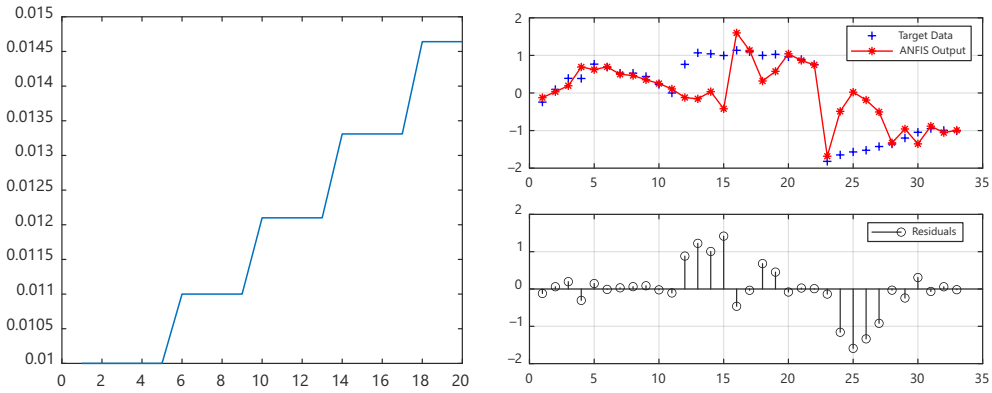

Figure 4. Characteristics of ANFIS model 4
(source: created by the authors in the Matlab software package, 2023)

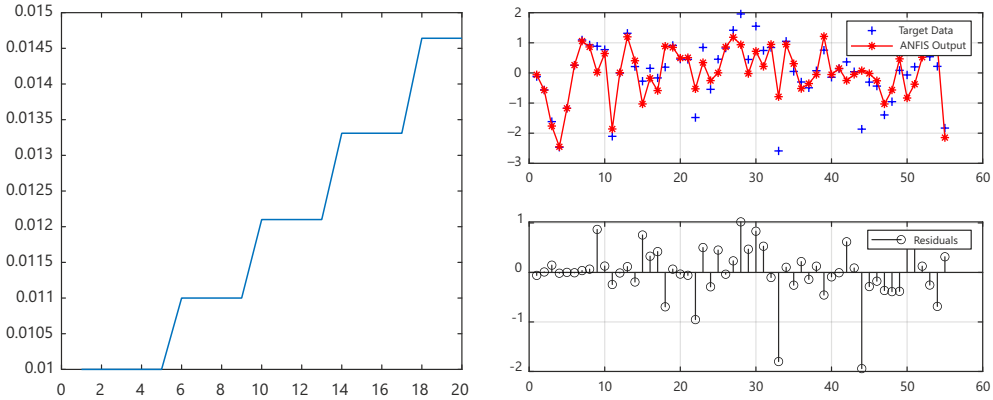

Figure 5. Characteristics of ANFIS model 5
(source: created by the authors in the Matlab software package, 2023)

Basic information about Model 5 can be described as:

- Number of nodes: 35.
- Number of linear parameters: 27.
- Number of nonlinear parameters: 18.
- Total number of parameters: 45.
- Number of training data pairs: 55.
- Number of checking data pairs: 0.
- Number of fuzzy rules: 9.
- Minimal training RMSE = 0.537705.

4. Results

An initial cluster analysis was made with the help of a dendrogram on the dataset of EU countries, which are also included in the EZ data described in Table 1. This analysis serves to link parameters and draw conclusions about their connection and causality.

Table 1. List of all observed variables for analyses (source: created by the authors, 2023)

No.	Name of the parameter
1.	GDP growth (annual %)
2.	Trade (% of GDP)
3.	Unemployment, total (% of total labour force) (modelled ILO estimate)
4.	Inflation, consumer prices (annual %)
5.	Gross fixed capital formation
6.	Interest rate
7.	GDP per capita
8.	Public debt (% of GDP)

The results of the first cluster analysis for EU countries that are also in the EZ are shown in Figure 6.

The analysis carried out in this way indicates the existence of two interconnected clusters. The first is dominated by two related sub-clusters: a) indicators Inflation, consumer prices (annual %) (4) and Gross fixed capital formation (5) and b) GDP growth (annual %) (1) and Trade (% of GDP) (2). The second one is dominated by Unemployment, total (% of total labour force) (3), which depends on GDP per capita (7), which in turn depends on the parameters Interest rate (6) and Public debt (8).

In summary, from the above results, it should be noted that in the observed countries GDP growth is closely related to trade, inflation and gross investments in fixed capital, while GDP per capita is related to unemployment, interest rates and public debt.

In this context, two ANFIS models were created for further analysis.

ANFIS Model 1 structure is:

Input 1 – Inflation, consumer prices.

Input 2 – Gross fixed capital formation.

Input 3 – Trade (% of GDP).

Output – GDP growth (annual %).

ANFIS model 1 is shown in Figure 7.

Low values of Inflation, consumer prices in combination with low values of Gross fixed capital formation contribute to high values of GDP growth (annual %) (relation Input 1 and Input 2 – yellow color in the figure).

Medium and high values of Inflation, consumer prices in combination with low values of Gross fixed capital formation contribute to low values of GDP growth (annual %) (relation Input 1 and Input 2 – blue color in the figure).

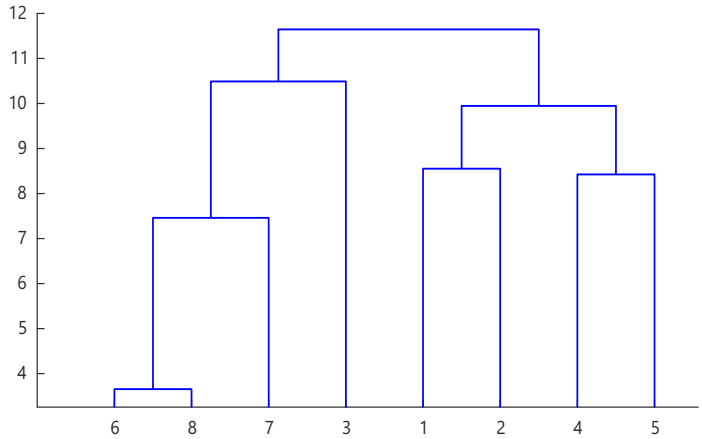

Figure 6. Results of the cluster analysis for EU countries (also in the EZ) (source: created by the authors in the Matlab software package, 2023)

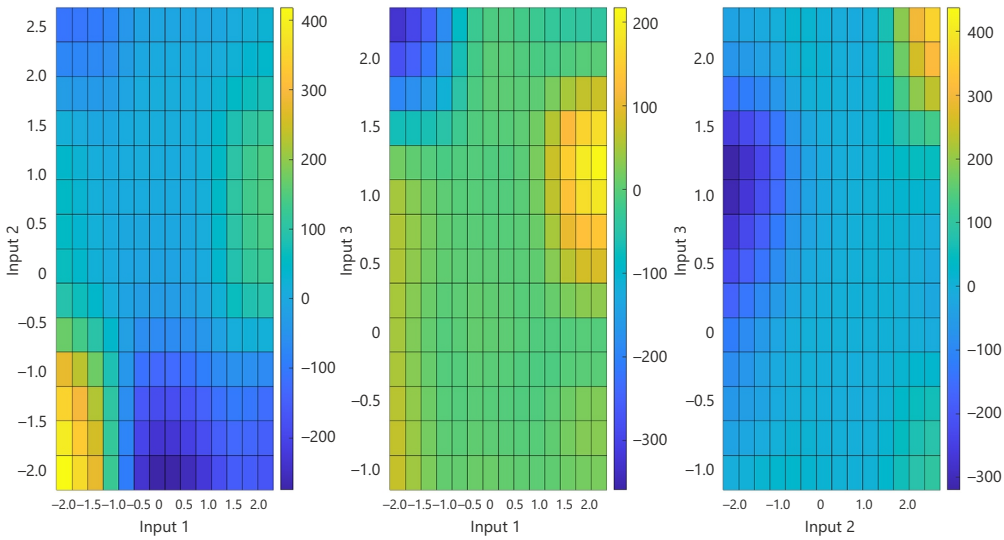

Figure 7. ANFIS model 1 (source: created by the authors, 2023)

Very high values of Inflation, consumer prices in combination with medium and high values of Trade (% of GDP) contribute to high values of GDP growth (annual %) (relation Input 1 and Input 3 – yellow color in the figure).

Low values of Inflation, consumer prices in combination with very high values of Trade (% of GDP) contribute to low values of GDP growth (annual %) (relation Input 1 and Input 3 – blue color in the figure).

Very high values of Gross fixed capital formation combined with very high values of Trade (% of GDP) contribute to very high values of GDP growth (annual %) (relation Input 2 and Input 3 – yellow color in the figure).

ANFIS Model 2 structure is:

Input 1 – Unemployment, total (% of total labour force).

Input 2 – Interest rate.

Input 3 – Public debt.

Output – GDP per capita.

ANFIS Model 2 is shown in Figure 8.

Low and medium values of Unemployment, total (% of total labour force) in combination with low values of Interest rate contribute to satisfactory and high values of GDP per capita (relation Input 1 and Input 2 – yellow color in the figure).

At all levels of values of Unemployment, total (% of total labour force) in case of simultaneous occurrence of medium and high values of Interest rate, this results in very low values of GDP per capita (relation Input 1 and Input 2 – blue color in the figure).

Average values of Unemployment, total (% of total labour force) with simultaneously low values of Public debt result in high values of GDP per capita (relation Input 1 and Input 3 – yellow color in the figure).

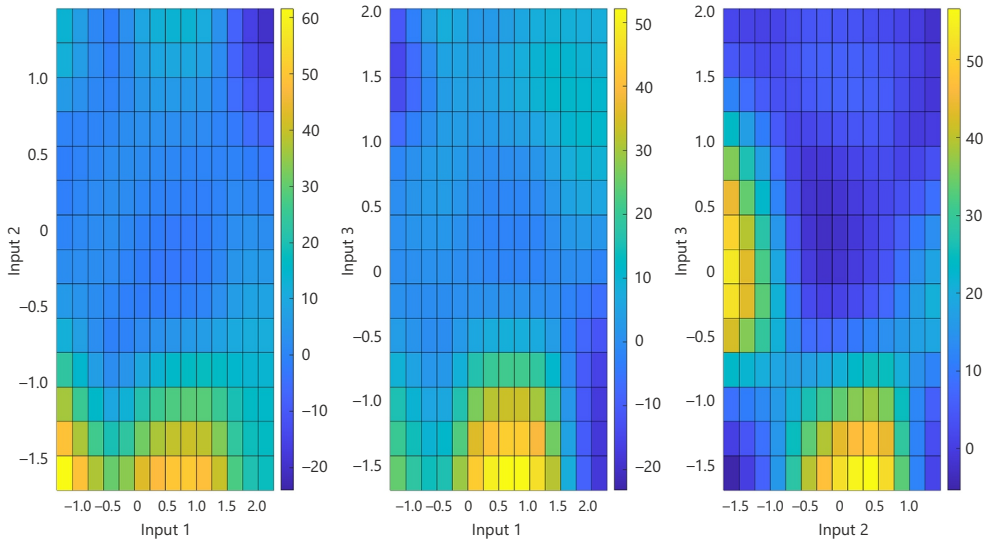

Figure 8. ANFIS model 2 (source: created by the authors, 2023)

Extremely low values of Interest rate with medium values of Public debt at the same time will result in high values of GDP per capita (relation Input 2 and Input 3 – yellow color in the figure). The same applies to the combination of medium interest rate values with low public debt values at the same time.

All other combinations of parameters Interest rate and Public debt contribute to low and very low values of GDP per capita (relation Input 2 and Input 3 – blue color in the figure).

The results of the cluster analysis for EU countries that are not in the EZ are shown in Figure 9.

Analysis of data for EU countries that are not in the EZ points to two interconnected clusters.

The first one is dominated by GDP growth (annual %), which depends on Unemployment, total (% of total labour force), and the latter on public debt and Interest rate.

The second is dominated by Trade (% of GDP), which depends on gross fixed capital formation and GDP per capita.

Inflation connects the mentioned two clusters, namely the parameters GDP growth (annual %) and Unemployment, total (% of total labor force) (modeled ILO estimate).

In this context, three ANFIS models were created for further analysis.

ANFIS Model 3

Input 1 – Unemployment, total (% of total labour force).

Input 2 – Public debt.

Input 3 – Interest rate.

Output – GDP growth (annual %).

ANFIS model 3 is shown in Figure 10.

Low and medium values of Unemployment, total (% of total labour force) in combination with low values of Public debt contribute to high values of GDP growth (annual %) (relation Input 1 and Input 2 – yellow color in the figure).

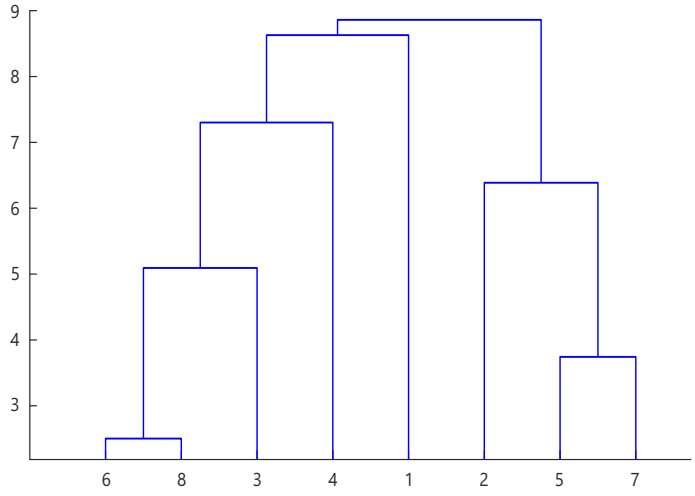

Figure 9. Results of the cluster analysis for EU countries (not in the EZ) (source: created by the authors, 2023)

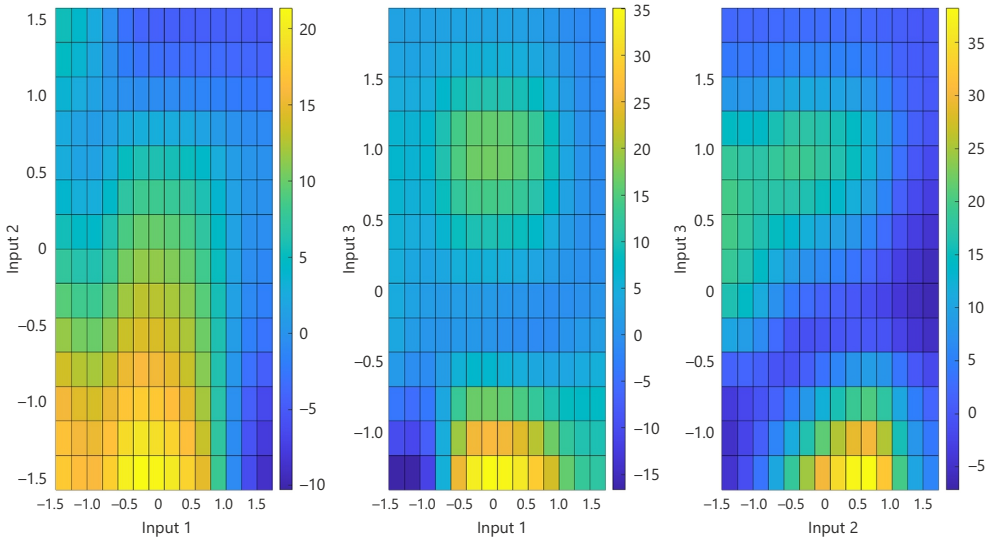

Figure 10. ANFIS model 3 (source: created by the authors, 2023)

Very high values of Unemployment, total (% of total labour force) in combination with all values of Public debt contribute to low and very low GDP growth (annual %) (relation Input 1 and Input 2 – blue color in the figure).

Average values of Unemployment, total (% of total labour force) in combination with extremely low values of Interest rate contribute to high values of GDP growth (annual %) (relation Input 1 and Input 3 – yellow color in the figure).

Extremely low values of Unemployment, total (% of total labour force) in combination with low and medium values of Interest rate contribute to low values of GDP growth (annual %) (relation Input 1 and Input 3 – blue color in the figure).

The combination of medium to high values of Public debt with the simultaneous presence of very low values of Interest rate contributes to very high values of GDP growth (annual %) (relation Input 2 and Input 3 – yellow color in the figure).

Very low values of Public debt with simultaneously low values of Interest rate as well as medium and high values of Public debt with medium values of Interest rate contribute to very low values of GDP growth (annual %) (relation Input 2 and Input 3 – blue color in the figure).

ANFIS Model 4

Input 1 – Gross fixed capital formation.

Input 2 – GDP per capita.

Output – Trade (% of GDP).

ANFIS model 4 is shown in Figure 11.

Medium values of Gross fixed capital formation with the simultaneous occurrence of very high values of GDP per capita contribute to very high values of Trade (% of GDP) (relation Input 1 and Input 2 – yellow color in the figure). All other combinations of Gross fixed capital formation and GDP per capita contribute to low values of Trade (% of GDP) (relation Input 1 and Input 2 – blue color in the figure).

ANFIS Model 5

Input 1 – Inflation.

Input 2 – Unemployment, total (% of total labor force).

Output – GDP growth (annual %).

ANFIS model 5 is shown in Figure 12.

This analysis indicates that in the observed countries high annual GDP growth (yellow color in the figure) is favored by a combination of a very high inflation rate (Input 1) and a very high unemployment rate (Input 2) or a combination of very high inflation (Input 1) and an extremely low-rate unemployment (Input 2).

The negative impact on GDP growth (blue color in the figure) is favored by a very low inflation rate combined with a very low unemployment rate at the same time.

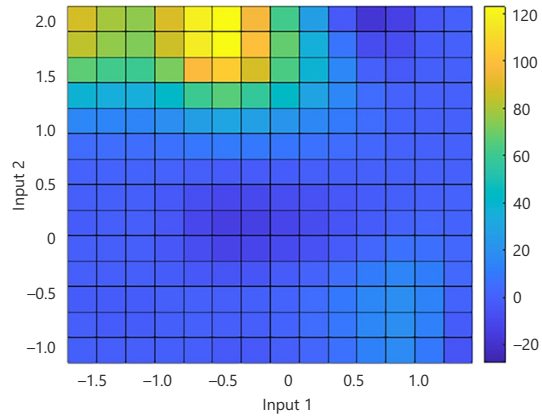

Figure 11. ANFIS model 4 (source: created by the authors, 2023)

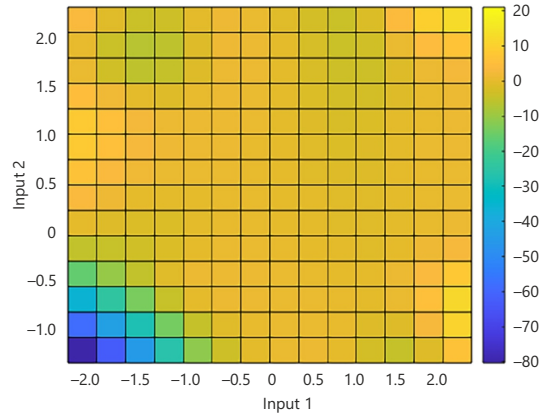

Figure 12. ANFIS model 5 (source: created by the authors, 2023)

5. Discussion

In order to obtain results and draw conclusions in this paper, it was not necessary to do a causality analysis because ANFIS is a form of artificial neural network that is designed to learn from data and generate predictions without being explicitly programmed with information regarding the causes of particular behaviors, i.e. it is not designed to identify the cause-effect relationships. Therefore, such effects were not even discussed.

The project of European integration is a continuous process in which countries first accede to the EU, whereat their ultimate goal should be to accede to the common monetary union. Just as accession to the EU is on a voluntary basis, so is accession to the eurozone. Countries that want to join the European Union and the monetary union should be interested in exactly these studies so that they can more easily see what kind of effects they can expect.

The conducted analyses have shown that in the observed period for EU countries that are also in the eurozone, GDP growth is expected to be closely related to trade, inflation and gross investments in fixed capital, while GDP per capita is related to unemployment, interest rates and public debt. The results also show that GDP growth at high rates occurs with low inflation values in the case of low values of Gross fixed capital formation. In the case of high inflation values, for GDP growth, it is necessary to achieve medium and high Trade (% of GDP) values (more in Mursa (2014)), which is confirmed by the current situation with inflation in the entire eurozone, which reaches very high percentages (in Croatia 13.4%), with the simultaneous presence of lower trade values. Furthermore, it is proven in the paper that high values of Gross fixed capital formation contribute to GDP growth with simultaneously high values of Trade (% of GDP), and high values of GDP per capita are favoured by low and medium unemployment values and at the same time low interest rates. The results obtained for the countries in the eurozone prove that the eurozone represents a further step in economic integration and is in line with other research by Gehringer (2013), Crespo Cuaresma et al. (2008) and Conti (2014), which deal with the connection between GDP growth and growth in trade, employment and gross fixed capital formation.

The time of low interest rates in the EU is behind us, which could be reflected in increased unemployment rates in the future. From the research on the determinants of unemployment in European countries, it is evident that the increase in interest rates has a strong influence on the increase in unemployment rates (more in Bosna (2022)). The research showed that in the case of medium unemployment values, for high GDP per capita values it is necessary to ensure low public debt values, which few EU countries can boast of. High values of GDP per capita occur in combinations of low values of Interest rate with simultaneously medium values of Public debt or medium values of Interest rate with simultaneously low values of Public debt.

On the other hand, our analysis for EU countries that are not in the eurozone showed that GDP growth (annual %) depended on Unemployment, total (% of total labor force), and it, in turn, on public debt and interest rate values. Trade (% of GDP) depends on gross fixed capital formation and GDP per capita, and for high GDP growth values it is necessary to ensure low to medium unemployment values, low Public debt values and low Interest rate values. In case the state has medium to high values of public debt, it is necessary to ensure extremely low

interest rates, which was the case with the entire EU in recent years. Furthermore, the average values of Gross fixed capital formation with the simultaneous occurrence of very high values of GDP per capita contribute to very high values of Trade. The obtained results are in accordance with the assumptions of Badinger (2005), Fernandez and Garcia-Perea (2015), Garoupa and Spruk (2020) and Georgiou (2020) that there is no big difference in the development of the two groups of countries (which is reflected in increased GDP, trade and decreased interest rate and public debt) that are in the eurozone and EU members that are not. Following the above, it can be concluded that the EU is very heterogeneous, and that each EU member has "its own story" which cannot be easily viewed from only one angle, and the growth and development of an EU country is influenced by many factors, not only whether it is in the eurozone or not. It is also important for our research to mention the world crisis of 2008/2009, which affected each of the observed countries differently. Countries that implement their structural reforms faster and more efficiently see greater benefits (Dauderstädt, 2021; Župerkienė et al., 2021). For this reason, peripheral countries benefit less from European integration, while the so-called core countries, i.e. the most developed EU countries benefited the most (Campos et al., 2019; Mion & Ponattu, 2019; Grabner & Hafele, 2020; Garoupa & Spruk, 2020). However, it should be noted that some Central East countries such as Poland and the Czech Republic achieved significant economic growth ten years after joining the EU.

Also, Model 4 shows that policies that promote investment in fixed assets can lead to economic growth and development, which can increase GDP per capita and promote trade. Similarly, policies that promote trade can lead to an increase in investment, which can lead to an increase in gross fixed capital formation.

Historically, politically, and economically, the EU is at a turning point. On the one hand, it is possible that further integration will continue, the strengthening of joint institutions such as the Banking Union (Petreski, 2007), Boitani and Tamborini (2020), which would result in a reduction of differences between the core countries and the periphery, especially with regard to the possibility of innovation and the level of technological equipment, competitiveness, sustainability, STEM education (Krstić et al., 2020). On the other hand, the disintegration of the European Union may start to happen, which would lead to increasing differences between developed member countries, and ultimately to the leaving of the European Union one by one, such as Brexit of Great Britain.

6. Conclusions

This paper makes its contribution to the literature of European integration, which further sheds light on the effects of monetary integration on the economic growth of countries. The paper is important for potential member states of the monetary union to see what effects they can expect from joining the eurozone.

In authors best knowledge, this is a first attempt at analyzing the impact of joining the eurozone on the economic growth of countries using the ANFIS method. In the literature, panel regression analysis, synthetic control method or simpler statistical methods of comparing average values of economic growth before and after a certain period are used to examine the

impact of the European integration for a group of countries. The results of this research are important because with a new methodological approach we complete the existing literature and make our own contribution to the continuous scientific research of European integration.

EU member states that have not entered the Eurozone and member states that are in the Eurozone to examine what the entry of a country into the Eurozone means regarding its economic growth, which is reflected in the growth of GDP, trade, employment, grossed fixed capital formation and controlled public debt, as reflected in the reduced interest rate, inflation rate.

The use of clustering through dendrograms and later ANFIS analysis enabled the authors to have a different approach to analysis through a kind of data storytelling, and a more detailed approach to interpreting the results than the commonly used methodologies in the study of these types of problems.

The obtained results were expected especially with regard to the public debt because it is one of the conditions for entering the Eurozone (it should not exceed 60% of GDP and the fiscal deficit should not exceed 3% of GDP). It has been proven that EU and eurozone members have the expected economic growth associated with trade growth. The entry of each country into the EU was reflected in increased mutual trade in the EU, which is the foundation of the idea of the EU as a large market that can compete on the world stage. The observed period of our research is characterized by low interest rates due to monetary relaxation, and therefore the results showed an important influence of low interest rates on the GDP of the observed countries. The connection between low unemployment rates and GDP growth has also been proven. At the beginning of 2023, the time of low interest rates is behind us, inflation rates are high, which overall slows down economic growth, increases unemployment rates and slows down trade. The European Union is at a turning point. Either it will continue to integrate, which is particularly related to the strengthening of common institutions such as the Banking Union, or it will disintegrate, and there will be a growing gap between the core EU countries and the EU countries on the periphery.

The practical implications of this research can be linked to policy guidelines for individual countries' entry into the Eurozone and the creation of a better economic environment for countries that are already part of the common monetary union especially in the fields of promoting trade and investment, enhancing economic stability, accelerating trade and macroeconomic stability, reducing internal economic divergences, and increasing economic and political advantages.

In addition to the theoretical part of the implications as a result of the obtained analyses, it is important to highlight the analysis approach itself, which, unlike classical approaches in the analysis of such problems, highlighted the application of clustering and ANFIS in the analysis as an excellent tool for a kind of data storytelling, which is also closely related to novelty of the paper. In connection with the above, it is important to point out the limitations, because it is not possible to examine the cause-and-effect relationships of the observed phenomena in this way, so they remain as a recommendation for some further research using a different methodology.

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