

# Examining regional economic differences in Europe: The power of ANFIS analysis

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## Abstract

The paper analyzes the interrelation between labour markets, demographic factors, and economic performance in Northern and Southeastern European countries during the period 2012–2023, using advanced ANFIS methodology. The aim of the study was to identify key differences between the developed countries of Northern Europe (Sweden, Norway, Finland) and the less developed countries of Southeastern Europe (Croatia, Bulgaria, Romania) and to pinpoint factors contributing to sustainable economic development. The research findings reveal significant differences in labour market structures, the impact of demographic factors, and resilience to macroeconomic shocks between the regions studied. Developed Northern European countries demonstrate high productivity levels, labour market stability, and resistance to inflation, while less developed Southeastern European countries are characterized by greater sensitivity to inflation and a higher dependency on low wages. The analysis highlights the need for structural reforms and increased investment in human capital and technology in less developed countries to reduce their reliance on volatile factors and foster sustainable growth. This paper contributes to understanding the complex relationships between labour markets, demographic factors, and economic performance and provides guidance for formulating effective public policies within the European Union.

Keywords: labour market, productivity, demography, sustainable economic growth, adaptive neuro-fuzzy inference system (ANFIS).

## 1. Introduction

In modern economies, labour market dynamics, demographic changes, and economic performance are key factors shaping economic growth and stability, as Maestas et al. (2016) argue. The connection between these elements is particularly evident in the comparison of countries of different levels of development, where differences in labour productivity, unemployment rates, and the size of the working population can reveal deeper structural challenges and opportunities for development, as discussed in Daron and Dell (2010) and Andabayeva et al. (2024). In this study, the focus is on comparing less developed countries in Southeast Europe (Croatia, Bulgaria, and Romania) with developed countries in Northern Europe (Sweden, Norway, and Finland).

The differences between these regions stem from the historical, political and economic circumstances that have shaped their labour markets and economic structures. While the developed countries of Northern Europe are characterized by high levels of productivity (Dabic-Miletic, 2023), stable labour markets and advanced technologies, the less developed countries of South-Eastern Europe face greater dependence on labour-intensive sectors, higher unemployment rates and demographic challenges, such as emigration and ageing populations. Although the labour markets of less developed countries are becoming more flexible and similar to those of developed European countries, as Asensio and Ferreira (2024) state, there is still much room for improvement. Future research should focus on comparative analyses of labour markets and macroeconomic indicators of developed and less developed groups of countries in order to reduce the research gap by analysing the interrelationships between labour market indicators and macroeconomic performance, which are interdependent.

Therefore, the aim of this paper is to investigate the interrelationship between economic growth, inflation, wage levels, the working population, unemployment rates and labour productivity (GDP per employee) and to analyse how these variables together affect the economic performance of the two observed regions. This research aims to identify key differences in labour markets and economic performance and to identify factors that contribute to sustainable economic development.

Such an analysis is of utmost importance for several reasons. First, it enables an understanding of the differences in development paths between developed and less developed countries and the identification of factors that slow down economic progress. Second, the research results can serve as guidelines for shaping public policies, especially in the context of less developed countries, which need effective strategies to increase labour productivity, reduce unemployment and adapt to demographic challenges. Finally, this research contributes to the academic debate on the relationship between demographic factors, labour markets and economic performance, which is crucial for shaping a cohesive and sustainable European Union.

The paper asks the following research questions: how do differences in labour markets and demographic factors affect economic growth and labour productivity in developed and less developed countries? Are there significant differences in the sensitivity of unemployment rates and wages to economic changes between these two groups of countries? And finally, to what extent does the working population contribute to sustainable economic development in different economic contexts?

It is assumed that developed countries in Northern Europe show higher levels of labour productivity and resilience to macroeconomic shocks due to technological innovation and more stable labour markets, while less developed countries in South-Eastern Europe depend on more labour-intensive sectors and face greater sensitivity to changes in demographic and market factors, according to a recent study by Lishchynskyy and Lyzun (2024).

The scientific contribution of this research stems from a comprehensive analysis of the interrelationship between the labour market, demographic factors, and economic performance in two regions of different levels of development. Using advanced ANFIS methodology, the work provides an innovative approach to understanding the complex relationships among key economic variables, while contributing to the development of a methodology for analysing nonlinear systems.

After this introductory chapter, the second chapter provides a review of relevant literature on the interrelationship between labour markets, demographic factors, and economic performance. The third chapter describes the materials and methods used in the study, including data sources and the application of the ANFIS methodology. The fourth chapter presents the results of the analysis, while the fifth chapter discusses key findings in the context of existing research. Finally, the sixth chapter concludes the study, highlighting policy implications and suggesting directions for future research

## 2. Literature review

Understanding the interrelationship between the labour market, demographic factors, and economic performance is essential because this interrelationship has a key impact on economic policymaking, market development, and long-term prospects for economic sustainability, as authors such as Fehr et al. (2010), Privara (2022), Bosna (2022a), Lupu et al. (2023) and many others have written about in their works.

The aforementioned authors state that understanding this connection allows decision-makers to develop long-term strategies that respond to labour market challenges, ensure sustainable economic growth and adequate social services, and reduce the potential negative effects of demographic change. Through a comprehensive approach, policies can be developed that balance the need for employment, education, health, and pension systems with labour market needs and general economic goals. These statements clearly indicate the need for a continuous and systematic approach to addressing this important area. In her work Siti Badriah (2024) as well as Khachatryan et al. (2023) emphasize that this connection becomes particularly pronounced in the context of different stages of economic development, where differences between developed and less developed countries are manifested in labour productivity, unemployment, demographic changes, and economic growth.

The Solow-Swan model of economic growth highlights the importance of technical progress and capital per employee as key factors for increasing productivity and long-term growth. Developed countries are characterized by high investments in human capital, research and development, and innovation, while less developed countries often depend on labour-intensive sectors and primary production (Barro, 1991). Labour productivity, defined as GDP per employee (Andrejić, 2022), is a key indicator of economic efficiency. High levels of labour productivity are often associated with investments in technology, education, and infrastructure development (André and Gal, 2024). In contrast, less developed countries face challenges such as low levels of investment, brain drain, and insufficient economic diversification.

The working-age population (15-64 years) is the main driver of economic growth. Changes in demographic structure, such as population aging or labour migration, can have a significant impact on the size of the labour force and, consequently, on economic growth (Huang et al., 2019). In developed countries, the labour market often makes up for labour shortages through automation and an influx of skilled migrants. Less developed countries, on the other hand, face the challenges of emigration of young and qualified population, which reduces their productivity and competitiveness. Unlike developed countries, such countries mostly import low-skilled labour in accordance with the structure of their economy (Moridian et al., 2024; Hairo et al., 2021). The Phillips curve indicates an inverse relationship between unemployment and inflation, which is the basis for analysing the stability of the economy. Developed countries often maintain lower unemployment rates and more stable inflation thanks to sophisticated monetary and fiscal policies. In less developed countries, high unemployment rates and fluctuating inflation often limit economic growth and cause social problems (Niken et al., 2023).

Studies on the economies of Norway, Sweden and Finland highlight high levels of investment in education, research and development, resulting in high GDP per employed and stable labour markets (Olafsson and Wadensjö, 2012; Svalund, 2013). These countries are successfully solving the challenges of population aging through active migration policies and digitalization of jobs (Pyrhönen et al., 2017). Empirical studies such as Drobnič et al. (2010) and Noda (2020) show that Northern European countries have a higher level of labour productivity due to better working conditions, a greater balance between private and professional life, and a higher share of high value-added sectors in their economies.

Croatia, Bulgaria and Romania face low levels of labour productivity and high rates of skilled labour outflow (Bossavie et al., 2022). Although these countries have recorded positive economic growth, it is often based on labour-intensive sectors such as agriculture, construction and tourism (OECD, 2024; World Bank, 2015). Unemployment is a significant problem, especially among young people, while demographic trends, including

population ageing and emigration, further strain economic sustainability. Studies show that less developed countries have less capacity to cope with economic shocks and less developed labour support systems (Bušelić and Bosna, 2019).

Comparisons between developed and less developed European countries show significant differences in the relationship between labour productivity, economic growth and the labour market. For example, Dmytrów and Bieszk-Stolorz (2021) highlight that Northern European countries achieve better coordination between education systems and labour markets, while South-Eastern European countries often lag behind due to a lack of institutional support. Previous research indicates significant differences in labour productivity, labour markets, and demographic trends between developed and less developed European countries. While developed countries record high levels of economic efficiency thanks to technological progress and strong institutional frameworks, less developed countries face challenges stemming from demographic changes, structural unemployment, and low levels of innovation (Puška et al, 2018). The debate on economic convergence within the Eurozone remains relevant, as some studies suggest that structural differences between member states continue to influence labour market flexibility and macroeconomic stability (Louzek, 2023). These disparities are particularly evident in the less developed regions of Southeastern Europe, where economic shocks have a stronger impact on employment and wage dynamics.

This research builds on previous work but adds value by analysing the interrelationships of key economic variables in different economic contexts using the ANFIS methodology. A particular contribution is seen in the comparison of regions to identify specific challenges and opportunities for sustainable economic development in Europe.

### 3. Materials and methods

In order to examine and compare the links between the labour market, demographic factors, and economic performance of developed and less developed European countries, three countries were selected to enter each group. The developed group consists of the Scandinavian countries: Sweden, Norway, and Finland, while the less developed group consists of the South-Eastern European countries: Bulgaria, Romania, and Croatia. The selection of the Scandinavian countries (Sweden, Norway, and Finland) and the South-Eastern European countries (Bulgaria, Romania, and Croatia) is based on their significant differences in economic development, demographic trends, and labour market dynamics. The Scandinavian countries, as highly developed economies, are characterized by a stable demographic profile, advanced social systems, and flexible labour market models, while the countries of South-East Europe face challenges such as depopulation, emigration, and lower investment in human capital. This division allows for the analysis of the impact of different policies and economic environments on the labour market, productivity, and economic performance. The comparison also contributes to understanding how to reduce economic inequalities within the European Union, making this research relevant for shaping future policies.

The timeframe from 2012 to 2023 was considered for several key reasons. First, 2012 marks the beginning of the stabilization after the global financial crisis and the eurozone debt crisis, which allows for the analysis of the post-crisis recovery and labour market transformation. The ten-year period provides a broader insight into economic cycles, including recovery, stagnation and recession. In addition, this decade encompasses key global events, such as the COVID-19 pandemic and geopolitical changes, which have strongly impacted the labour market and productivity.

The availability of up-to-date and reliable data for this period further justifies the choice, while in the European context, policies such as the Europe 2020 strategy (Cismaş et al., 2023), which have shaped economic growth and the labour market, stand out in particular. Also, in this period, the importance of sustainable development and the green economy is growing, which is significant for the analysis of long-term economic trends and working conditions. All of the above makes this period relevant and representative for thorough analysis.

The variables included in the analysis are: GDP growth rate, inflation, wages, the working-age population, unemployment rate, and labour productivity. GDP growth refers to the annual percentage growth rate of real GDP (2015 is a base year) and serves as an indicator of economic activity. Inflation is measured by the annual percentage change in the consumer price index (2015 is a base year).

Wages represent the total material compensation of employees, expressed in real values. The population aged 15-64 represents the total number of working-age individuals. The unemployment rate indicates the proportion of unemployed individuals in the total workforce, while labour productivity is measured as GDP per person employed.

The economic growth rate and inflation were selected for the analysis of macroeconomic indicators because they provide key information about the overall health and stability of the economy. Economic growth reflects the country's ability to create added value and increase living standards, while inflation indicates the stability of prices and purchasing power, which directly affects business cycles and the labour market.

Total material compensation of employees, the number of working-age population, the unemployment rate and labour productivity were selected for labour market indicators because they provide insight into labour as a key resource of the economy. Material compensation reflects the value of labour and the demand for labour, while the working-age population provides a framework for the availability of resources in the labour market. The unemployment rate indicates the efficiency of the labour market and the ability of the economy to generate jobs, and labour productivity represents a unit of measurement of the economic performance of employees and is a key indicator of the competitiveness and long-term sustainability of the economy.

Together, these indicators provide a comprehensive approach to analysing the interrelationship of the labour market, demography and economic performance, which is crucial for comparing developed and less developed countries.

Annual data for all analysed variables were sourced from the World Bank database, except for GDP growth expressed as a percentage, which was obtained from the Eurostat database.

Data analysis used two methods: clustering using dendrograms and adaptive neuro-fuzzy inference system (ANFIS). Before analysis, all data were standardized (Fazlollahabadi, 2022). Hierarchical clustering was performed using dendrograms to develop a basis for further analysis. ANFIS was chosen because of its exceptional ability to integrate fuzzy logic and learn neural networks, which enables the approximation of non-linear functions (Brlčić Valčić et al., 2021).

This methodology is particularly useful for the analysis of non-stationary time series because it enables the recognition of patterns and trends without the need for the data to be stationary. ANFIS combines the advantages of fuzzy logic, which enables working with uncertain and unclear data, and neural networks, which enable automatic learning from data (Darwito and Indayu, 2023). By using ANFIS, it is possible to analyse the interconnection of input variables and their influence on the output variable based on complex non-linear relationships (Bosna et al., 2024).

Using the grid partitioning method, a fuzzy logic system (Fuzzy Inference System - FIS) was generated using the Fuzzy Logic Toolbox in the MathWorks MATLAB R2019b software package. On the basis of dendrogram analysis, four ANFIS models have been established that have variable inputs called Input ( $x_i$ ) grouped into fuzzy sets. Based on the input variables, fuzzy rules were generated in the IF-THEN format, which have the form:

$$\text{IF } (x_1 \text{ is } A_1) \text{ AND } (x_2 \text{ is } A_2) \text{ AND } (x_3 \text{ is } A_3) \text{ THEN } (y_i = p_i x_1 + q_i x_2 + r_i x_3 + s_i) \quad (1)$$

whereby  $A_1, A_2, A_3$  are fuzzy sets of input variables, while  $p_i, q_i, r_i, s_i$  are parameters that determine output values and are optimized during training. To define fuzzy sets, a bell-shaped function was used that describes the degree of belonging of each point in the input space to a fuzzy set:

$$\mu_{A_i} = \frac{1}{1 + \frac{|x - c_i|^{2b_i}}{a_i}} \quad (2)$$

Parameters  $a$ ,  $b$ ,  $c$  define the shape, width and centre of the membership function and are adjusted during training. One of the key results of the ANFIS analysis is a graphic representation of the mutual relations of inputs ( $x_i$ ) and their influence on the output variable ( $y_i$ ), presented in the form of a colour palette. This colour palette clearly visualizes the strength of the connection, where certain shades indicate weaker or stronger influence. For example, more intense colours may indicate a stronger connection, while more subtle colours indicate a weaker connection. Based on these graphical representations, it is possible to identify the key inputs that have the most influence on the output variable and to analyse how these influences change depending on the input changes (Brelčić Valčić et al., 2021).

This approach enables a detailed interpretation of the results and more precise drawing of conclusions about the system being analysed, since visualization in the form of colours provides an intuitive way to detect patterns and relationships between variables. Thus, the strength of the connection between input and output can be clearly quantified and compared, which further strengthens the interpretation of the results and the understanding of the system.

The use of sensitivity analysis through the ANFIS methodology in this research is justified due to its unique advantages in modeling complex nonlinear relationships between economic variables. ANFIS combines the strengths of fuzzy logic and neural networks, enabling the integration of uncertain or imprecise data with automatic learning. This methodology is ideal for analyzing economic systems where the relationships between variables are often nonlinear, such as the connections between wages, economic growth, and unemployment rates. The application of ANFIS enables precise definition of thresholds and boundaries that influence output variables. These thresholds are methodologically justified as ANFIS allows for the quantification of relationships between variables within defined intervals, thereby identifying critical points of change in the system (Brelčić Valčić et al., 2021).

#### 4. Results

Clustering using dendrograms facilitates identifying relationships between parameters and deriving insights about their interconnections for model establishments. On the X-axis in all cluster analyses there are numbers representing individual variables - GDP growth (1), Inflation (2), Wages (3), Working age population (4), Unemployment (5) and GDP per person employed (6). The results of the dendrogram in Figure 1 reveal the presence of two key clusters for the countries of Southeastern Europe.

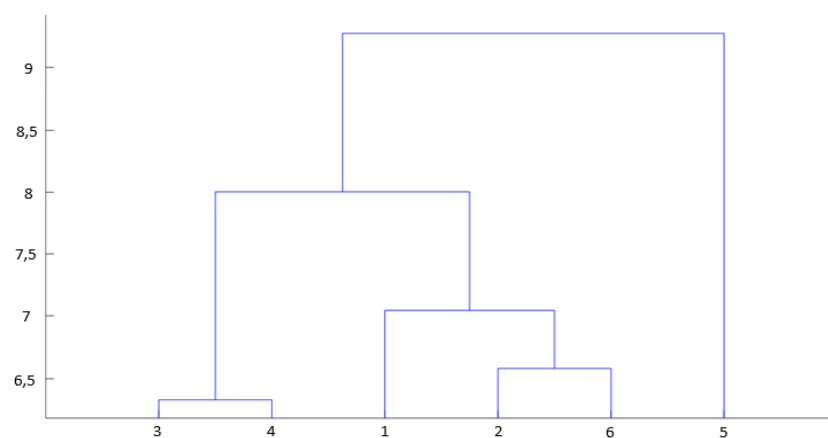


Figure 1. Results of the cluster analysis for South-Eastern European countries

The first cluster connects the economic growth rate, wages, the working-age population, and unemployment. The dominant role of unemployment within this cluster highlights its critical relationship with other economic variables. Cluster analysis shows that the unemployment rate (5) is strongly correlated with wages (3) and the working-age population (4) and moderately correlated with GDP growth rate (1). The Pearson correlation between unemployment and wages is -0.51, between unemployment and the working-age population -0.47, and between unemployment and economic growth -0.32, indicating their significant interrelationship.

The second cluster (a subset of the first) links inflation, the economic growth rate, and GDP per employee. Economic growth dominates here, suggesting its importance in connecting productivity and inflation. Inflation (2) and GDP per employee (6) form a subset within the second cluster. The correlation between inflation and GDP per employee is -0.35, suggesting that rising inflation negatively impacts labour productivity.

ANFIS Model 1 structure is: GDP growth rate (Input 1), Wages (Input 2), Population (Input 3) and Unemployment (output). The results of the ANFIS model 1 are shown in Figure 2.

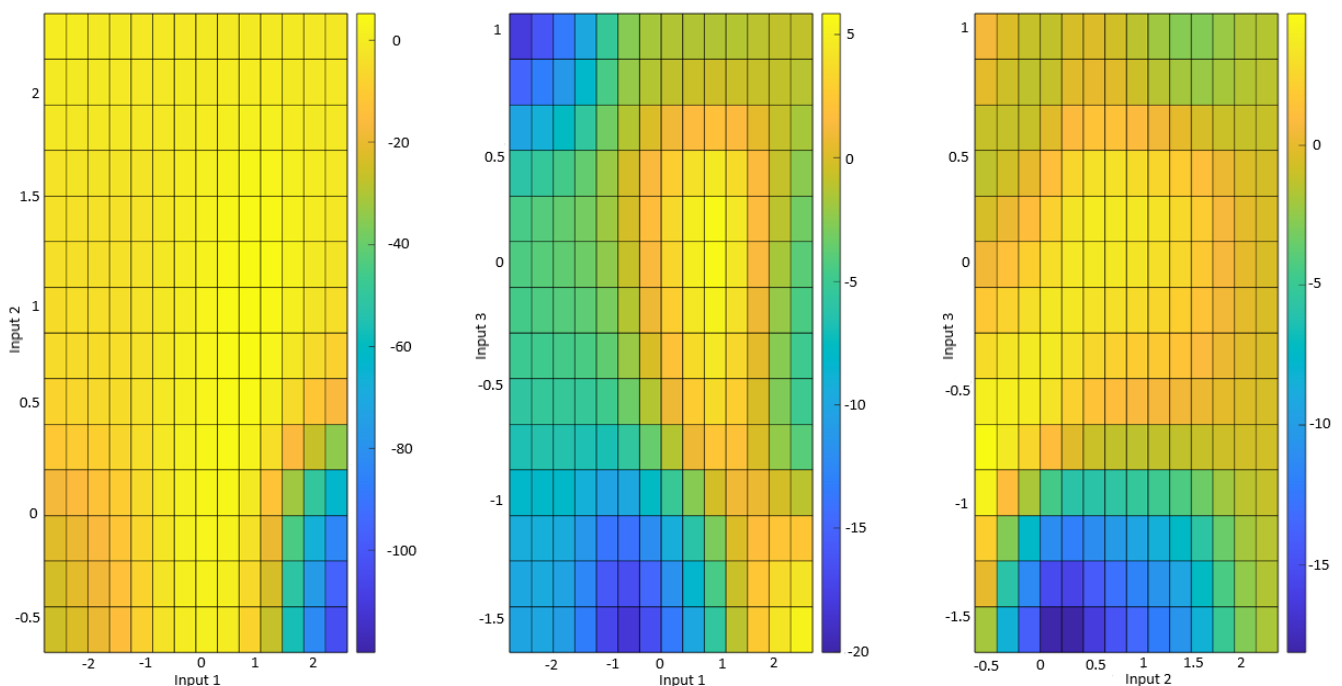


Figure 2. ANFIS model 1

The model demonstrates that a combination of low wages and high economic growth rates leads to a reduction in the unemployment rate. Conversely, high wages and low economic growth rates increase unemployment, indicating limited labour market flexibility and the sensitivity of these countries' economies to wage fluctuations. Supporting this is the finding that a combination of low wages and lower levels of the working-age population leads to a decrease in unemployment, with the opposite also holding true. Higher wages and higher levels of the working-age population result in an increase in unemployment.

The model quantitatively illustrates the impact of low wages and high economic growth on reducing unemployment. The results show that when wages are  $\leq 63.43\%$  of the median value and annual GDP growth is  $\geq 5\%$ , the unemployment rate decreases to  $\leq 5.61\%$ . Conversely, a combination of high wages ( $\geq 168.97\%$  of the median value) and low GDP growth ( $\leq 1.56\%$ ) increases the unemployment rate to  $\geq 11.98\%$ , highlighting the limited adaptability of the labour market.

The ANFIS Model 2 structure is: Inflation (Input 1), GDP per person employed, (Input 2) and GDP growth rate (Output). Results of the ANFIS Model 2 is shown in Figure 3.

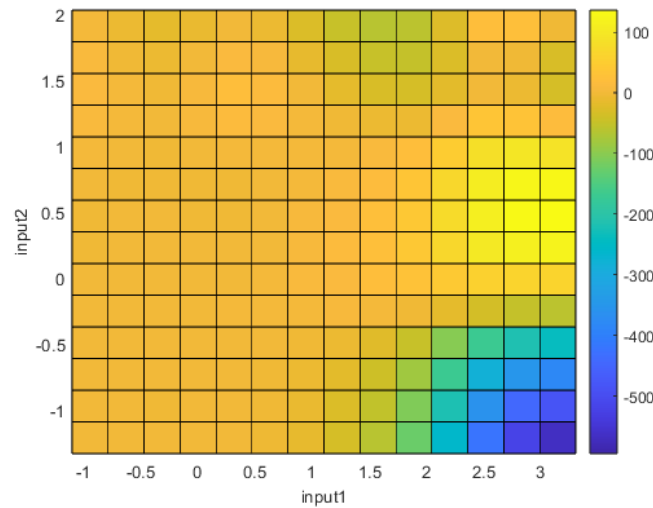


Figure 3. ANFIS model 2

Inflation plays a crucial role in shaping economic growth. High inflation combined with high employee productivity drives GDP growth, while low productivity paired with high inflation negatively impacts growth. The results suggest that increasing productivity can mitigate the negative effects of inflation and promote sustainable economic growth.

The combination of inflation (Input 1) and employee productivity (Input 2) makes a significant contribution to economic growth. The model indicates that when inflation ranges between 3.63% and 13.30%, and productivity grows to a level  $\geq 116.68\%$  of the median value, GDP growth rates reach  $\geq 5.00\%$ . Conversely, high inflation ( $\geq 2.98\%$ ) combined with low employee productivity ( $\leq 94.67\%$  of the median value) reduces GDP growth rates to  $\leq 1.56\%$ .

The results of the cluster analysis for developed countries are presented in Figure 4. The dendrogram for developed countries identifies two clusters linked through the economic growth rate. These clusters include variables such as wages, inflation, labour productivity, the working-age population, and unemployment.

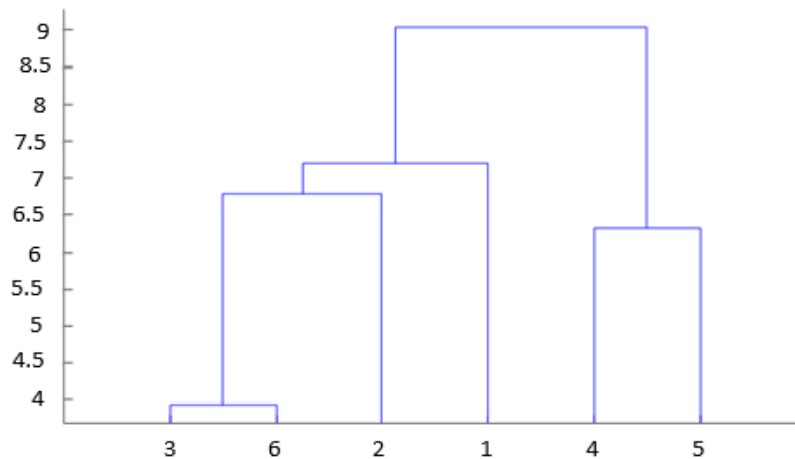


Figure 4. Results of the cluster analysis for the Northern European group of countries

Cluster analysis highlights the relationship between unemployment (5), the working-age population (4), and economic growth (1). The correlation between the working-age population and economic growth is 0.27, while there is a negative correlation of -0.12 between unemployment and economic growth.

The second cluster includes wages (3), inflation (2), and employee productivity (6). The correlation between wages and employee productivity is 0.76, confirming the importance of balancing wages and productivity for stable economic growth.

This relationship emphasizes the complex interconnections between macroeconomic variables and points to a more stable labour market in developed countries. In this context, two ANFIS models (model 3 and model 4) were created for further analysis.

ANFIS Model 3 has consisted of Population (Input 1), Unemployment (Input 2) and GDP growth rate (Output). Results of the ANFIS model 3 is shown in Figure 5.

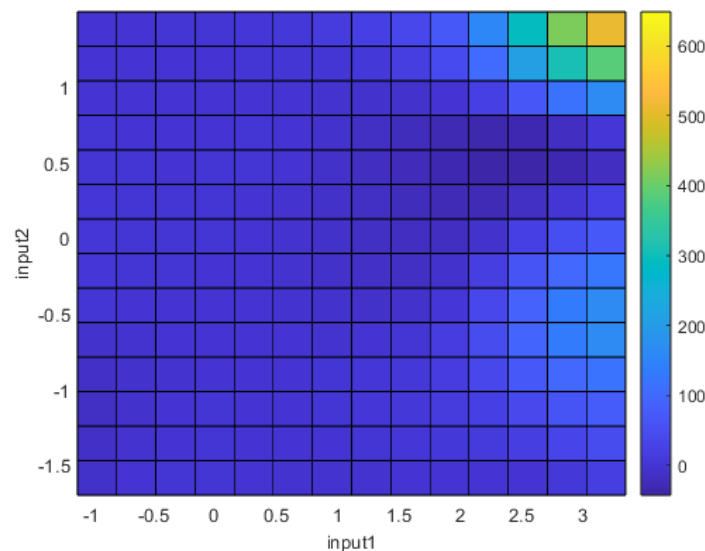


Figure 5. ANFIS model 3

The model highlights that a combination of high employment rates and high unemployment can generate high economic growth rates. This indicates that developed countries manage the labour market more effectively, even under conditions of high unemployment.

The model shows that only exceptionally high employment rates ( $\geq 111.58\%$  of the median value) combined with high unemployment ( $\geq 6.9\%$ ) result in GDP growth of  $\geq 2.76\%$ . A low level of the working-age population ( $\leq 97.94\%$  of the median value) combined with unemployment of  $\geq 8.19\%$  results in negative economic growth ( $\leq -0.4\%$ ).

Furthermore, ANFIS Model 4 consists of Compensations (Input 1), GDP per person employed (Input 2), Inflation (Input 3), and GDP growth rate (Output). The results of ANFIS model 4 are shown in Figure 6.

The combination of low wages and medium productivity levels is associated with high economic growth. However, extremely high or low wages combined with extreme productivity levels often lead to low growth, emphasizing the importance of balancing these indicators. High inflation combined with low wages stimulates economic growth, while low employee productivity coupled with high inflation negatively impacts growth.

The combination of wages (Input 1) and employee productivity (Input 2) plays a key role. Low wages ( $\leq 73.39\%$  of the median value) combined with medium productivity (from 99.23% to 105.25% of the median value) contribute to GDP growth of  $\geq 4.5\%$ . Extremely low wages ( $\leq 71.45\%$  of the median value) combined with inflation between 1.66% and 2.61% of the median value increase the economic growth rate to  $\geq 2.55\%$ .

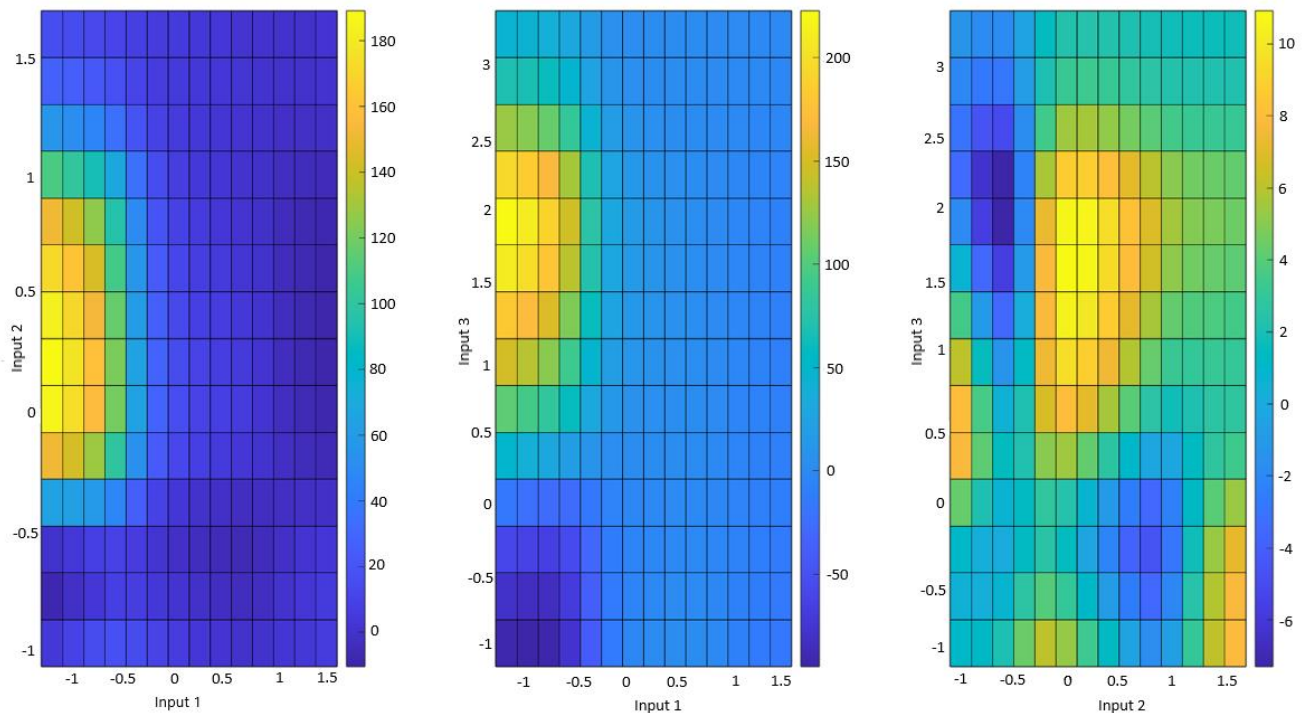


Figure 6. ANFIS model 4

## 5. Discussion

Developed countries show greater labour market flexibility, with better ability to manage unemployment and the working-age population. In contrast, less developed countries are more sensitive to changes in wages and inflation. Less developed countries have a more sensitive labour market, as seen through the negative correlation between inflation and unemployment. While there has been progress in labour market flexibility in Southeast European countries, significant opportunities for improvement remain (Bosna, 2022b). Developed countries demonstrate a higher degree of resilience between the working-age population and economic growth.

In both regions, productivity is a key factor for economic growth. However, less developed countries show greater sensitivity to inflation and low wages, while developed countries successfully use inflation as a stimulus tool. Inflation strongly impacts economic growth in less developed countries, whereas its role is more moderate in developed countries.

Developed countries rely on stable productivity and moderate wages for sustainable growth, while less developed countries often use low wages as a competitive advantage. Low wages in less developed countries reduce unemployment, whereas in developed countries, their impact on growth depends on productivity.

The sensitivity analysis thus confirms the complex relationships between the labour market, inflation, and economic growth in both regions. While developed countries use a balanced combination of inflation, wages, and productivity for sustainable growth, less developed countries rely on low wages and high inflation as temporary adjustment mechanisms. The results point to the need for structured reforms in less developed countries to reduce their dependency on unstable factors and promote sustainable growth. In their work, Vidović and Ritan (2023) highlight the complex interrelationships between macroeconomic indicators and the labour market and point to the structural challenges faced by less developed countries.

The results indicate key differences in labour market structures and economic performance between developed and less developed countries. While developed countries in Northern Europe successfully balance various variables, less developed countries in Southeast Europe face greater challenges due to their sensitivity to wages,

inflation, and low productivity. This suggests that higher wages reduce the competitiveness of less developed economies, making them less attractive for investment, as noted by Van Biesebroeck (2015). This analysis emphasizes the importance of investing in human capital and technology to stimulate long-term economic growth.

## 6. Conclusion

This research provides a detailed insight into the complex relationships between the labour market, demographic factors, and economic performance in developed countries of Northern Europe and less developed countries of Southeastern Europe during the period from 2012 to 2023. Using advanced ANFIS methodology, key patterns and differences in economic variables that define sustainable economic growth and resilience to macroeconomic shocks have been identified.

Developed countries in Northern Europe, thanks to stable labour markets, high productivity, and innovative technologies, exhibit greater resilience to inflation and macroeconomic changes. In contrast, less developed countries in Southeastern Europe face challenges such as greater sensitivity to inflation, dependence on low wages, and lower labour productivity. Although reforms in Southeastern European countries have improved labour market flexibility, their structural challenges still limit economic progress.

Sensitivity analysis further indicate in the numerical form, key differences in the impact of inflation, wages and productivity on economic growth. In developed countries, these variables act as mutually balancing factors of sustainable growth, while in less developed countries, high inflation and low wages are temporary adjustment tools, but at the same time reduce long-term competitiveness. The results also suggest that investments in human capital, technological modernization and structural reforms are key to reducing dependence on low wages and fostering sustainable economic development in less developed countries.

This research provides a significant practical contribution by offering guidelines for shaping public policies that support strengthening the labour market, increasing productivity, and adapting to demographic challenges. It also contributes to the academic debate by providing an innovative methodology for analyzing nonlinear relationships between economic variables, thus expanding the understanding of structural challenges and opportunities in the development of economies across different regions of Europe. The results of this research emphasize the importance of a balanced approach to economic policies in order to enable sustainable economic growth and reduce development disparities within the European Union.

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## References

- Andabayeva, G., Movchun, V., Dubovik, M., Kurpebayeva, G., & Cai, X. (2024). Labour market dynamics in developing countries: Analysis of employment transformation at the macro-level. *Journal of Innovation and Entrepreneurship*, 13, 65.
- André, C., & Gal, P. (2024). Reviving productivity growth: A review of policies. OECD Economics Department Working Papers No. 1822. <https://dx.doi.org/10.1787/61244acd-en>, Accessed 12 October 2024.
- Andrejić, M. (2022). Different Approaches for Performance Appraisal and Bonus Calculation: The Case of Truck Drivers. *Journal of Intelligent Management Decision*, 1(2), 97-107.
- Asensio, M., & Ferreira, C. (2024). Labour-market Reforms in Southern Europe: From Protection to Flexibility. In P. C. Kostis (Ed.), *Economic Recessions - Navigating Economies in a Volatile World and the Path for Economic Resilience and Development* (pp. 1-29). IntechOpen.
- Barro, R. J. (1991). Economic Growth across countries. *The Quarterly Journal of Economics*, 106(2), 407-443.

- Bosna, J. (2022a). The Determinants of Unemployment: CSEE Countries Panel Data Analysis. *Scientific Papers of the University of Pardubice. Series D, Faculty of Economics and Administration*, 30(1), 1384.
- Bosna, J. (2022b). The Influence of Negative Demographic Trends on Unemployment: a Comparative Analysis of CSEE Countries. In *Proceedings of the 39th International Business Information Management Association Conference*(pp. 362-368). Norristown (PA): International Business Information Management Association.
- Bosna, J., Brlečić Valčić, S., & Peša, A. (2024). Measuring the effect of entry into the eurozone on economic growth – data storytelling using clustering and ANFIS. *Technological and Economic Development of Economy*, 30(3), 646–666.
- Bossavie, L., Garrote-Sánchez, D., Makovec, M., & Özden, C. (2022). *Skilled Migration: A Sign of Europe’s Divide or Integration?*. Washington, DC: World Bank. <https://hdl.handle.net/10986/37101>, Accessed 11 October 2024.
- Brlečić Valčić, S., Samodol, A., & Valčić, M. (2021). Using ANFIS in joint dynamics of monetization, financial development, public debt and unemployment analysis. *Ekonomski vjesnik/Econviews - Review of Contemporary Business, Entrepreneurship and Economic Issue*, 3(1), 23-40.
- Bušelić, M., & Bosna, J. (2019). Defining the Unemployment Determinants of the Post-Transition Central European EU Member Countries. *Managing global transitions*, 17(1), 79-103.
- Cismaş, L. M., Boţoteanu, G. I., Cojocar, T. M., & Gruescu, R. M. (2023). Significance of Corporate Non-Financial Information Disclosure for Sustainable Economic Growth. *Journal of Green Economy and Low-Carbon Development*, 2(1), 1-10.
- Dabic-Miletic, S. (2023). Advanced Technologies in Smart Factories: A Cornerstone of Industry 4.0. *Journal of Industrial Intelligence*, 1(3), 148-157.
- Daron, A., & Dell. M. (2010). Productivity Differences between and within Countries. *American Economic Journal: Macroeconomics*, 2(1): 169–188.
- Darwito, P. A., & Indayu, N. (2023). Adaptive Neuro-Fuzzy Inference System Based on Sliding Mode Control for Quadcopter Trajectory Tracking with the Presence of External Disturbance. *Journal of Intelligent Systems and Control*, 2(1), 33-46.
- Dmytrów, K., & Bieszk-Stolorz, B. (2021). Comparison of changes in the labour markets of post-communist countries with other EU member states. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 16(4), 741-764.
- Drobnič, S., Beham, B., & Präg, P. (2010). Good Job, Good Life? Working Conditions and Quality of Life in Europe. *Social Indicators Research*, 99, 205–225.
- Fazlollahtabar, H. (2022). Intelligent Marketing Decision Model Based on Customer Behavior Using Integrated Possibility Theory and K-Means Algorithm. *Journal of Intelligent Management Decision*, 1(2), 88-96.
- Fehr, H., Jokisch, S., & Kotlikoff, L. (2010). Global growth, ageing, and inequality across and within generations. *Oxford review of economic policy*, 26(4), 636-654.
- Hairo, A., Caprar, D., V., Zikic, J., & Stahl, G., K. (2021). Global migrants: Understanding the implications for international business and management. *Journal of World Business*, 56(2), 101192.
- Huang, W.-H., Lin, Y.-J., & Lee, H.-F. (2019). Impact of Population and Workforce Aging on Economic Growth: Case Study of Taiwan. *Sustainability*, 11(22), 6301.
- Khachatryan, V., Nepyaliuk, A., Pasichnyi, M., Nasibova, O., & Tabenska, J. (2023). Demographics’ impact on economic growth in central europe and the baltic states. *Economics - innovative and economics research journal*, 11(1), 37-54.
- Lishchynskyy, I., & Lyzun, M. (2024). Pattern of European Regional Creativity: exploring endogenous sustainability. *Economics - innovative and economics research journal*, 12(3), 397 – 407.
- Louzek, M. (2023). Is the Eurozone an optimum currency area?. *International Journal of Economic Sciences*, 12(2), 63-82.

- Lupu, D., Cărăusu, D.M., & Ifrim, M. (2023.) Wage share and economic growth: evidence from Eastern Europe. *Applied Economics Letters*, 30(6), 772-779.
- Maestas, N., Mullen, K. J., & Powell, D. (2023). The Effect of Population Aging on Economic Growth, the Labour Force, and Productivity. *American Economic Journal: Macroeconomics*, 15(2), 306-332.
- Moridian, A., Radulescu, M., Kumar, P., Tatiana, M., & Mohammad, R. J. (2024). New insights on immigration, fiscal policy and unemployment rate in EU countries – A quantile regression approach. *Heliyon*, 10(13), e33519.
- Niken, K., Haile, M. A., & Berecha, A. (2023). On the nexus of inflation, unemployment, and economic growth in Ethiopia. *Heliyon*, 9(4), e15271.
- Noda, H. (2020). Work-Life Balance and Life Satisfaction in OECD Countries: A Cross-Sectional Analysis. *Journal of Happiness Studies*, 21(4), 1325-1348.
- OECD. (2024). Towards Balanced Regional Development in Croatia: From Strategy Design to Implementation. *OECD Multi-level Governance Studies*. Paris: OECD Publishing, Paris. <https://doi.org/10.1787/3c0779cf-en>, Accessed 12 October 2024.
- Olofsson, J., & Wadensjö, E. (2012). Youth, Education and Labour Market in the Nordic Countries: Similar But Not the Same. Berlin: Friedrich Ebert Stiftung.
- Privara, A. (2022). Economic growth and labour market in the European Union: lessons from COVID-19. *Oeconomia Copernicana*, 13(2), 355-377.
- Puška, A., Maksimović, A., & Stojanović, I., (2018). Improving organizational learning by sharing information through innovative supply chain in agri-food companies from Bosnia and Herzegovina. *Operational Research in Engineering Sciences: Theory and Applications*, 1(1), 76-90.
- Pyrhönen, N., Leinonen, J., & Martikainen, T. (2017). Nordic migration and integration research: overview and future prospects. Policy paper 3. NordForsk. <https://norden.diva-portal.org/smash/get/diva2:1085791/FULLTEXT01.pdf>, Accessed 10 October 2024.
- Siti Badriah, L. A. (2024). The dynamics model of cross-regional to enhance economic growth: new empirical evidence from indonesia. *Economics - innovative and economics research journal*, 12(3), 379 - 395.
- Svalund, J. (2013). Labour Market Institutions, Mobility, and Dualization in the Nordic Countries. *Nordic Journal of Working Life Studies*, 3(1), 123–144.
- Van Biesebroeck, J. (2015). How tight is the link between wages and productivity? A survey of the literature. *Conditions of work and employment series No 54*. Geneva: International Labor Office.
- Vidović, N., & Ritan, V. (2022). New approach to estimating macroeconomic determinants of informal employment. *Economics - innovative and economics research journal*, 10(2), 95-108.
- World Bank. (2015). Productivity in Bulgaria: Trends and Options. Source: <https://www.worldbank.org/content/dam/Worldbank/document/eca/Bulgaria/Bulgaria-Productivity-6-26-15-eng-web.pdf>, Accessed 10 October 2024.