

The influence of wage and employment on competitiveness: An assessment

*Laima Okunevičiūtė Neverauskienė, Romualdas Ginevičius,
Irena Danilevičienė*

Abstract

Competitiveness is defined as the ability to provide services and products to the market at the right time, in the right place and in the correct form. In this way, the need to disclose the value of work payment is formed, because the standard of living and a person's position in society depend on the income received. At the national level, the wages received reveal the country's ability to pay the expected amount for the work performed and evaluate the benefits created by employees for the entire economy. The need to determine an adequate salary directly related to the achieved work results and to predict the required number of employees to accomplish the intended work results with the least resources becomes apparent. The topic of this paper is the competitiveness of E.U. countries and their relationship with wages and employment. The objective is to evaluate how changes in wages and employment affect the country's competitiveness. To achieve this, the following tasks are undertaken: analyzing the theoretical aspects of compensation, employment, and competitiveness, and identifying the key factors that influence competitiveness. Additionally, a methodology for assessing the country's competitiveness is developed to evaluate the impact of wages, employment, and other factors on its overall competitiveness. The work uses the following methods of scientific literature analysis: systematization, juxtaposition, summarization of scientific concepts and empirical research results, hypothesis formulation, correlation-regression analysis, overall productivity factor, and Granger causality test. An analysis of political, economic, social, and technological changes revealed that wages and employment levels are central to modeling competitiveness growth. Granger causality tests confirmed a cointegrated relationship, emphasizing that wage growth is critical for boosting employee motivation, preventing company bankruptcies, and increasing employment levels. This, in turn, fosters competitiveness at both company and national levels.

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1 INTRODUCTION

Competitiveness and operational efficiency, which manifest themselves in low unemployment and the ability to create jobs and increase profits, are areas of interest for many economists. In the modern world, competitiveness is a conditional and dynamic economic category analyzed in various sections by many researchers (Yordan et al., 2017; Sudirjo, 2023). The modern concept of competitiveness was formed in the 20th century. In the results of comparative economic research conducted in the United States, competitiveness implies an ability to effectively position itself within an industry and achieve and sustain a competitive advantage over competitors (Vasiliev, 2022; Hart & Rodgers, 2024). In this way, the need to disclose the value of work payment is formed, because the standard of living and a person's position in

society depend on the income received. At the national level, the wages received reveal the country's ability to pay the expected amount for the work performed and evaluate the benefits created by employees for the entire economy. The need to determine an adequate salary directly related to the achieved work results and to predict the required number of employees to accomplish the intended work results with the least resources becomes apparent.

In 1990, M. Porter began broadly analyzing competitiveness and moved it from the micro to the macro level. A country's competitiveness is a complex category characterized by market participation, real income growth, changes and productivity of production resources, employment level and economic efficiency, and a strong exchange rate (Sudirjo, 2023; Keil, 2024). The realization of this condition characterizes its ability to be competitive and use available resources for social and economic well-being (Yordan et al., 2017).

The object of this study is the competitiveness of E.U. countries and their relationship with wages and employment. The goal is to assess the impact of wage and employment changes on a country's competitiveness. To achieve the goal, the following tasks are solved:

- Analyzing the theoretical aspects of remuneration, employment, and competitiveness and identifying the most important factors determining competitiveness.
- Create a methodology for assessing a country's competitiveness.
- To assess the impact of wages, employment and other factors on a country's competitiveness.

This study uses the following methods of scientific literature analysis: systematization, juxtaposition, summarization of scientific concepts and empirical research results, hypothesis formulation, correlation-regression analysis, overall productivity factor, and Granger causality test.

This paper consists of 3 main parts: theoretical analysis, methodology part, and practical part. In the theoretical part, a deep analysis of scientific articles about competitiveness, wages and economic development is made. The methodological part includes the analysis of the used methods: Granger causality, productivity factor, and others. In the practical part, the impact of wages, employment and other factors on the country's competitiveness is described.

2 THEORETICAL BACKGROUND

Competitiveness is often described in different aspects as a multifaceted and multidimensional concept. Most often, competitiveness is characterized by the fact that a good salary is paid for the work performed, which would be adequate for the efforts put forth and would motivate the employee to work productively. Also, competitiveness is associated with employment, because for a country to be competitive and well-regarded in the context of other countries, the level of employment should be as high as possible. And, of course, competitiveness can be evaluated through the prism of productivity, because as the productivity of employees on both the company and state scales increases, so does the competitiveness (of both companies and the country). This paper assesses competitiveness precisely through the disclosure of the relationship between productivity, wages and employment. To assess competitiveness properly at the beginning, aspects in which wages, employment and productivity affect competitiveness should be defined.

2.1. Theoretical aspects of wage

When assessing a country's economic processes or factors of economic development, the importance of remuneration as the primary motivational lever of human resources becomes

apparent. Depending on the subjective opinion of the researcher and the results of the conducted research, a particular phenomenon is evaluated differently, so the concept of the object presented may also differ. Analyzing the idea of labor payment, it seems that many researchers (Bargain & Peichl, 2016; Leoni & Gritti, 2017; Leap et al., 2023) examine the concept of labor payment from various aspects, and their perceptions differ. However, the researchers emphasize that remuneration is a broader category, including wages with material value and other non-material motivational factors (better working conditions, praise, or participation in training courses). This paper examines the materially assessed part of the work payment in more detail - wages.

Salary is analyzed based on legal, economic, managerial, and psychological positions. In the legal sense, wages are for work performed by an employee under an employment contract (Daigrepoint & Douville, 2024). Other researchers (Leap et al., 2023) agree and claim that wages reflect the employer-employee relationship. When solving work payment issues, the interests of employees and employers are compatible with the principles of social partnership or in conflict with each other. At the time of the conclusion of the employment contract, an appropriate remuneration for the work performed was agreed upon; therefore, in this regard, remuneration is perceived as an agreement to perform certain functions for an appropriate wage.

Economically, wages are evaluated as various forms of financial feedback and tangible benefits or rewards calculated according to the expected hourly rates (Bargain & Peichl, 2016; Thoresson, 2024). They are a reward paid to workers for using the available labor force, corresponding to the general price level and showing the work's actual value. Wages for every employee are the most important source of income, which ensure the person's social prestige and affect their living standards, consumption and even the country's economic situation. The salary received reflects a person's position in society and relations with its members.

At the junction of management and psychology sciences, salary is considered one of the main motivating factors for working and working productively. It follows that the amount of salary reflects the nature of the work and the competencies and qualifications of the employee (Leoni & Gritti, 2017; Bassier & Ranchhod, 2024) and therefore helps to assess the image of the profession and is one of the main factors that encourage choosing a suitable workplace. The salary should be adequate for the employee's professional knowledge and dedication to the work performed and their qualifications, so the employee must constantly improve their qualifications and acquire the necessary knowledge.

In summary, wages as an economic category are treated broadly. However, in the most general case, they can be defined as a monetary expression of the value of labor power or simply the employee's obligation to "sell" their labor to the employer, who in turn undertakes the responsibility to pay the remuneration stipulated in the employment contract for correctly performed work. It follows that wages reflect the quality of human capital (consumption, educational and motivational quality).

Wage structure

It is necessary to determine its structure precisely to pay a salary adequate to the available skills. It is claimed that a properly selected wage structure creates conditions for effectively achieving activities strategic goals and increasing employee activities' efficiency, fairness and legitimacy. It follows that the wage system should be supported by internal compatibility, external competitiveness, employee effort (contribution), and proper administration of the wage system.

An adequately structured salary should assess the suitability of employees' qualifications for the workplace and promote the productivity of their activities.

Furthermore, it is concluded that the combination of wages and productivity levels typical of developing countries is achievable. Over the long term, productivity plays a critical role in determining a country's relative competitiveness, potential GDP growth, real wage levels, and overall economic well-being. Although some argue that countries with low labor productivity can enhance their competitiveness by lowering costs and prices, evidence suggests there is no significant correlation between reduced relative costs and prices within an economy and its share of international market trade (Antonakakis et al., 2024).

Many scientific works (Wieczorek, 2013; Leap et al., 2023), propose to divide wages into direct (central) wages, which include monetary remuneration and working conditions beneficial to the employee, and indirect (non-main) wages, which include related benefits: recognition, status, challenging work or tangible and intangible remuneration.

Other works (Wieczorek, 2013; Carreno et al., 2024) propose dividing the salary into permanent and variable parts. This can be done in several ways. One is when the salary does not depend on performance results but on the position held, financial responsibility, decisions made, the size of the organization, the nature of the activity, and the level of salary in other similar companies and the country. In this way, the aim is to encourage employees to make riskier decisions and achieve maximum returns. On the other hand, employees who cannot regulate performance expect higher returns generated by higher-ranking employees (managers). The second proposal is when the salary depends on a variable that depends on the company's performance. This type of evaluation should include a cause and effect relationship that would show employees' contributions to increasing the efficiency of the company's operations. In this way, employees will be encouraged to achieve better performance and improve the company's well-being. The third method is mixed, where the salary could be composed of fixed and variable parts. In this case, the negative wage factors are eliminated, and only the question of the proportion of inclusion of the factors remains. It is argued that the level of wages should be so high that the company could stop paying variable wages when its performance indicators are unsatisfactory. The amount of the variable portion should be based on performance criteria to ensure long-term positive profits. Employees should receive a fixed salary and a variable part (bonuses). In this case, the complex wage is understood through the changes in its internal structure, which manifests itself through the gradual equalization of the importance of the variables of the complex wage for employees and the inclusion of tangible and intangible recognition variables of employees. The complex wage structure covers all the most critical aspects of wage determination. This structure is unique in that indirect wages appear, which manifest themselves precisely through non-monetary benefits for the employee. Exact means of recognition are one of the most important factors motivating employees to work productively, providing them with satisfaction from their work, and making it possible to maintain a balance between work and personal life (work-life balance). At the same time, the country's economic situation is improved, and competitiveness is increased. Part of direct wages consists of material incentives for employees (wages and monetary bonuses determined to be adequate for the volume of work performed). Applying a complex salary structure also promotes healthy global competition and highlights the need to attract as many talented, creative and efficient employees as possible. When determining the salary and applying the presented structure, it is also necessary to consider the factors that have a direct (or indirect) influence on the salary amount. Considering these factors' influence, it is necessary to react flexibly and determine the "correct" wage.

2.2. Theoretical concepts of employment

To examine the relationship between employees and employers, it is essential to define the concept of employment and understand its significance for the economy. Employment is examined from various angles and can be understood as a link between the economy and commercial relations, managerial skills and competitiveness, and, on the other hand, as a source of job protection, economic dependence, and regulation. This paper presents three essential blocks of interpreting employment concepts: economic, social, and legal.

In the scientific literature (Ling et al., 2024), employment is defined in the economic sense as the ratio of the number of working people of working age to the total workforce. In this case, full employment occurs when all willing (and able) employed persons can find work. In examining employment from a social perspective, Mandl (2017) emphasizes the concept of full employment, as a relationship between an employee and an employer aimed at jointly creating a product or delivering a service to meet customer needs. Employment is intentionally structured to facilitate collaboration between the employee and employer toward this shared objective. A key aspect of employment is that employees must receive compensation for their contributions, as employment relationships arise when an individual is engaged for a specific period to perform designated tasks in exchange for monetary remuneration. Therefore, employment is fundamentally a form of paid work. From a legal perspective, the employment relationship between an employee and an employer must be formalized through a contract, whereby both parties agree to the regulation of working hours, the length of the workweek, and other working conditions (Zaccaria, 2015). In the case of traditional employment, the employee is hired by signing a permanent employment contract and agreeing to a full-time schedule (eight hours a day) over five days a week. This arrangement represents stable, long-term employment. Establishing a legal relationship between the employer and employee creates a hierarchical structure, with the employer acting as the manager and assigning tasks that the employee is expected to carry out in exchange for an agreed-upon compensation (salary).

In summary, employment is the use of available skills, qualifications, and abilities for financial gain - wages as a fair reward for the work put forth and the proper execution of instructions. The division of workers and labor is the best in terms of working conditions and impact on labor relations because the employer considers the needs and expectations of the workers and tries to maintain a good working relationship. In contrast, in the case of regular work, although there is an effort to consider the needs of the workers, information and computer technology is increasing the necessity of technology applications at work. The form of cooperative employment is characterized by the fact that the employee has more autonomy and the nature of the work has completely changed (the employee decides on the working time, which technology to choose when performing the work, etc.).

2.3. The aspects of competitiveness and its relationship with productivity

Competitiveness is a conditional and dynamic economic concept that is generally studied in various aspects (Lotfi & Karim, 2016; Źmuda & Molendowski, 2016; Yordan et al., 2017; Oyewole et al., 2024). The term originated in the 20th century. In the beginning, in the United States, comparative studies of the economic situation were carried out, and competitiveness was defined as overcoming competitors by selling products and providing services to the consumer under the most favorable conditions. The popularity of competition research increased significantly in the 1970s.

In the most general sense, competitiveness is the ability to provide services and products to the market at the right time, in the right place and the proper form, requiring customers to pay an

appropriate price that is lower than competitors but covering the incurred production costs (Lotfi & Karim, 2016). Competitiveness is understood as the ability of subjects of a particular activity to earn, lead and compete with others to achieve better performance results by performing work faster, working productively, with quality, and applying innovative methods (Yordan et al., 2017; Keil, 2024) and to increase market share.

Also, the concept of competitiveness is described as the ability to maintain high living standards and ensure sustainability for employees if they can create a high-quality product and maintain an adequate level of product quality. In this regard, stable economic growth fosters the population's well-being (Alexandro & Basrowi, 2024). The principles of sustainability also have an impact on competitiveness (Oyewole et al., 2024), because it proposes future directions for global markets and for productivity growth.

The modern concept of competitiveness is a multidimensional feature that results from internal characteristics and is related to the ability of regions to adapt to constantly changing socio-economic conditions and attract investments. It also aims for economic development and competitive success in other areas and wants to create new conditions for economic development. In the era of globalization, competition is driven by the availability of capital, the level of technical expertise, and the proficiency of skilled professionals (Žmuda & Molendowski, 2016). Adequate infrastructure plays a crucial role in supporting this growth, enabling the efficient production and distribution of goods and services (Haji, 2021; Alexandro & Basrowi, 2024). A nation's global competitiveness significantly depends on its ability to deliver effective macroeconomic infrastructure. In this context, competitiveness becomes a key factor in attracting foreign investments and fostering international business growth (Khurshid et al., 2023). Achieving a competitive edge over other market participants requires leveraging greater resources, developing new skills, and acquiring essential capabilities. Its purpose follows from the concept of competitiveness - to create prerequisites for learning and applying modern technologies in business (Yordan et al., 2017). In this way, efforts are made to increase productivity, reduce the deficit, traditional barriers and the social security network, and increase the real income of the population, which is reflected in the improvement of the living standards of the population (Lotfi & Karim, 2016).

It follows that competitiveness is a multifaceted phenomenon that can be examined at various levels. Competitiveness is studied at the enterprise, sector, regional, country, or international level.

The competitiveness of a company is understood as its ability to increase its market share by producing and selling high-quality products or services that fulfill the demands of its target market. This involves competition among business units for customers, raw materials, labor, and innovation. Achieving competitiveness can be done through cost reduction, product diversification, or by focusing on a specific niche (Sudirjo, 2023; Sui et al., 2024). The more effectively a company adapts to market needs, the greater market share it can capture. This adaptation is defined by four key elements of competitiveness: potential, advantage, instruments, and position.

From an economic perspective, competition at the company level is a process in which market participants strive to offer more favorable terms—such as better prices, quality, and delivery conditions—to influence decision-making in transaction agreements (Sudirjo, 2023; Situmorang et al., 2024). Competitiveness, in this context, refers to the micro (company) level, where companies with similar profiles compete for customers and aim to maximize their

internal resources. Companies facing competition have four strategic options: to compete aggressively, limit competition, or avoid/ignore it (Sudirjo, 2023).

Several aspects of the evaluation of the country's competitiveness are distinguished (Alzate et al., 2024; Keil, 2024):

- Foreign trade perspective (advocates of foreign trade define competition as a shared effort to capture international markets, where competitiveness grows with increasing export volumes in the global market, influenced by price and other factors);
- Productivity perspective of the country (the nation's objective of improving and continuously raising the standard of living for its population is dependent on the ability of domestic companies to achieve high productivity levels, maintain growth, and effectively sell, adapt, and leverage the nation's location advantages);
- Well-being assurance perspective (competitiveness is seen as the capacity to create well-being for the population, providing opportunities for employment (with high wages) and social benefits (such as education, healthcare, democracy, and social justice)).

The application of competitive abilities using the appropriate competition instruments leads to the essence of a competitive advantage. To benefit from participation in the division of labor, more advanced factors of competitiveness must be used. In this way, efforts are made to achieve the necessary competitive position (better international trade results, more perfect use of production factors, and quantity-quality evolution).

The main reasons for the growth of competitiveness become apparent:

- The globalization of the economy facilitates the movement of goods, services, capital, people, and knowledge, driven by advancements in information technologies and transportation systems.
- Population concentration leads to the accumulation of potential, which generates new demands, needs, and opportunities.
- The pace of economic and social development accelerates when scientific knowledge is applied in practice more efficiently.

In conclusion, the competitiveness of regions (countries) cannot be directly transferred from the level of companies because regions are not a set of companies, and companies are not a reduced version of a country. The competitiveness of companies affects the competitiveness of the region where this company operates, and regional competitiveness factors affect the competitiveness of individual companies. All economic, political, social, economic and infrastructural factors impact the formation of competitiveness of companies and the country.

2.3.1. Factors affecting competitiveness

Competitiveness represents the dynamic rivalry among service providers or goods producers striving to operate under optimal conditions, minimize incurred costs, and maximize obtained benefits. The capacity to compete effectively and surpass rivals is influenced by a combination of internal and external factors. The majority of these factors tend to have a qualitative rather than quantitative impact on competitiveness. A structured overview of the factors influencing competitiveness is illustrated in Fig. 1.

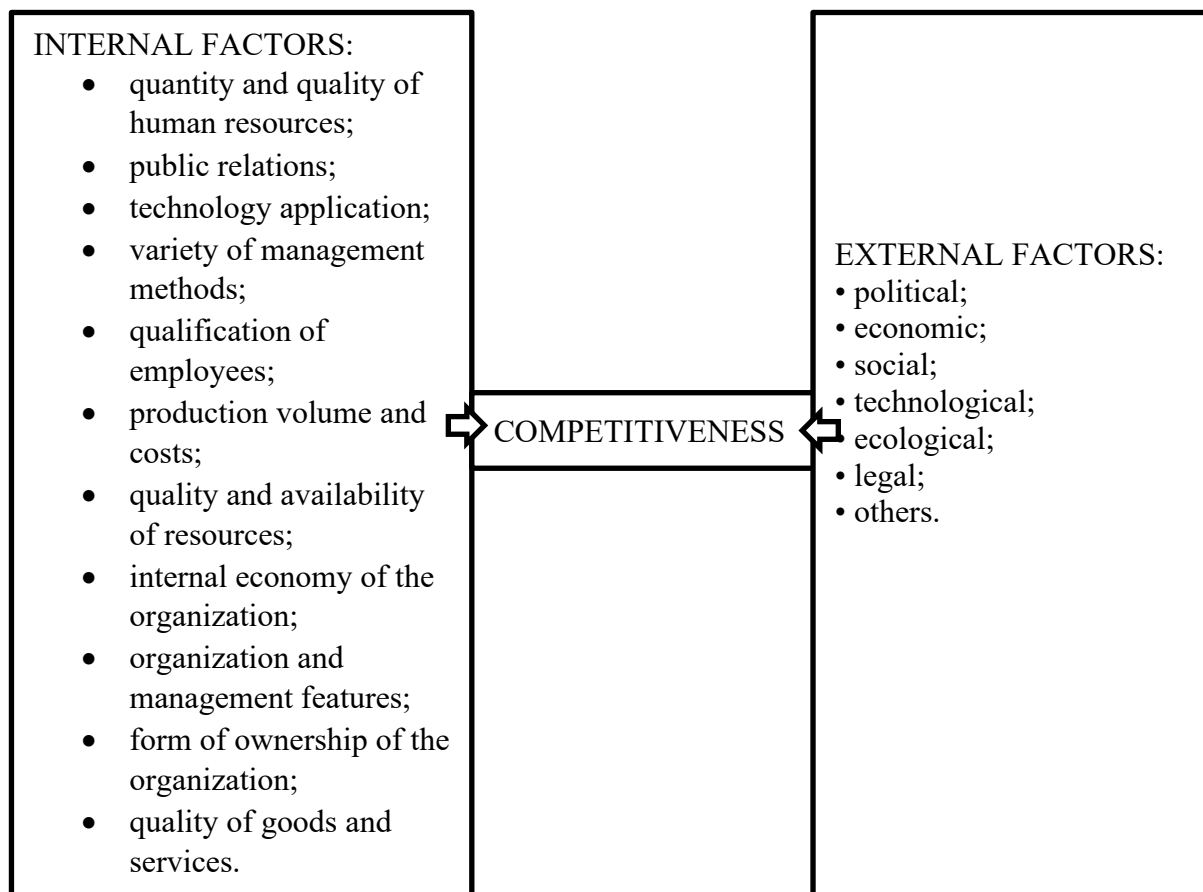


Fig. 1 – Factors affecting competitiveness. Source: compiled by the author based on Lotfi & Karim, 2016; Sudirjo, 2023; Shah et al., 2024

From Fig. 1 we see that all factors that affect a country’s competitiveness are divided into internal and external.

Internal factors affect a country’s competitiveness through the competitiveness of individual companies or economic sectors. Internal factors can be divided into larger groups (Sudirjo, 2023): human capital factors (quantity and quality of human resources, qualifications of employees), characteristics of products and services (quality and availability of resources, technologies, volume of production and costs, quality of goods and services), and characteristics of the organization/branch (form of ownership of the organization, variety of management methods, internal economy of the organization, peculiarities of organization and management, public relations).

The factors influencing a country’s competitiveness can be categorized into four groups: completely uncontrollable (such as geographical conditions), short-term uncontrollable that can be controlled in the long term (such as infrastructure and qualifications), controlled by higher-level institutions whose control is influenced by political factors and lobbying (such as government policy), and directly controlled (such as resources).

After analyzing and comparing different approaches to assessing competitiveness (from the perspectives of foreign trade, national productivity, and the welfare of the population), we concluded that evaluating productivity from a country’s perspective is most appropriate. During this evaluation, it is crucial to consider the factors affecting competitiveness: internal (which

influence the country's competitiveness through the performance of individual companies or sectors) and external (which operate on a global scale). Most of these factors have a more qualitative than quantitative impact and can be either fully controlled or completely uncontrollable.

Following an analysis of the conceptual foundations of political, legal, economic, social, technological, and environmental changes and their effects on competitiveness, we concluded that wage levels and employment volumes should form the core of the impact assessment model for factors driving competitiveness growth.

3 RESEARCH OBJECTIVE, METHODOLOGY AND DATA

Competitiveness is usually evaluated through the ability of companies to obtain a positive result. In order for the results to meet expectations, the ability of employees to work productively, the ability of companies to pay better wages to employees, and the ability to increase employee employment should be assessed. Estimating competitiveness is an important part of economic research. During the evaluation process, finer evaluation aspects are determined, which help to evaluate strategic decisions of economic development considering common criteria and different sources of economic competitiveness. Orientation to the knowledge economy is of exceptional importance for E.U. countries, because knowledge is valued in modern society, and the concept of a knowledge-based society is perceived as an aspirational ideal of a competitive country.

To increase competitiveness, the main aspects of its evaluation are distinguished (Farida & Setiawan, 2022):

- relative and absolute advantage (the importance of country-specific advantages (economic characteristics) is emphasized, dependence on the ability to use resources, minimization of production costs);
- types of structure of market and their impact on competitiveness (degree of monopolization, impact on competition, oligopolies, the influence of perfect competition on market processes);
- theoretical and empirical studies of competitiveness (available resources and their use, production capacity, government's role and costs, market share, economies of scale);
- formation of competitive strategies (importance of exclusive competencies, product quality, innovations and investments, information systems);
- political, legal and cultural aspects of competitiveness (competitiveness is inseparable from the historically formed political, cultural and geographical aspects of globalization).

Both price and other factors can determine competitiveness. Researchers (Dhehibi et al., 2016; Lotfi & Karim, 2016; Sudirjo, 2023) offer several ways of evaluating competitiveness and productivity through the prism of wages and employment, which are discussed in the following subsections of this paper. To assess the macro environment in a more detailed manner, indicators such as intense competition, international competitiveness, and comparative advantage should be used.

Total productivity factor as a tool for assessing economic competitiveness

The impact of a country's political, economic, social, and technological environment on economic progress has been extensively studied in recent years. It is becoming increasingly acknowledged that social, historical, cultural, institutional, and political factors, along with the

administrative framework, are crucial in shaping development processes, especially in relation to national and regional growth and business productivity. Macroeconomic factors such as institutional quality, openness to international trade, and geographical conditions are key determinants of long-term productivity and economic growth. Various methods are available to evaluate a country's economic performance, with productivity being assessed through two key dimensions: factors driving productivity growth and processes that support productivity at the national level. In this context, technological advancements stand out as the primary driver of productivity improvement. Economic development is often measured through different approaches, among which calculating the total productivity factor is considered a particularly effective analytical method.

Special attention of researchers (Lasagni et al., 2015; Dhehibi et al., 2016) is paid to applying the total productivity factor (TPF) in macroeconomic research. Labor productivity is identified with TPF. TPF is a measure of productivity, an essential indicator of the political situation, and the most critical driver of economic growth or a method that defines the percentage contribution of capital, labor and general factor productivity to the growth of the gross domestic product. TPF can also be understood as technical progress broadly (Shah et al., 2024), which is closely related to a human capital, innovation, infrastructure, tax regime and regulatory framework (Shah et al., 2024). If GDP growth is high, shifting labor from low to high productivity levels can lead to expansion and growth. Based on the results obtained, it is possible to decide which components (labor of capital) should be invested in to increase productivity.

Total productivity growth is a clear measure of innovation, which is an idea, technique or object that becomes acceptable at the personal and national level. This indicates the importance of innovation dynamics in the production process. Innovation is a multifaceted and difficulty measured phenomenon. The dynamics of innovation are strictly technology-specific and vary across sectors, so there is an opportunity to use new knowledge for productivity growth. As a result, there is an opportunity to produce innovative products and use technological innovation (Shah et al., 2024).

In 1942, Tinbergen defined the production function, which Solow (1957) further developed. TPF is the residual of the Cobb-Douglas production function (formula 1).

$$Q = AL_a K_b \quad (1)$$

where:

Q – quantity of production;

A – productivity factor;

L and K - production factors (labor and capital);

a and b - coefficients.

The production function reflects GDP (Y) as a combination of input factors - labor (L) and capital (K), excess capacity (U_L, U_K) and adjusted efficiency level (E_L, E_K). In practice, the Cobb-Douglas specification is chosen for an adequate functional form, and it follows that the potential GDP is expressed based on formula (2).

$$Y = (U_L L E_L)^\alpha (U_K K E_K)^{1-\alpha} = L^\alpha K^{1-\alpha} * TFP \quad (2)$$

The total productivity factor (TFP) is defined based on formula (3).

$$TFP = (E_L^\alpha E_K^{1-\alpha})(U_L^\alpha U_K^{1-\alpha}) \quad (3)$$

In this context, both the technological level and inputs are measured in physical units. However, the primary basis for the overall productivity factor remains investments and their efficiency.

The trend of TFP is estimated from the Solow residual using the Kalman filter method, which leverages the relationship between the TFP cycle and capacity utilization. The Solow residual is computed for forecasting GDP, labor costs, and capital stock, which allows for the extension of the GDP series with two additional observations. Since no predictors are used, two missing estimates are calculated within the model, and TFP is estimated based on the available data.

Labor resources refer to the quantity of professionally qualified personnel employed. Efficiency is largely determined by the number of people working in a given area. If an organization has sufficient labor resources and utilizes them efficiently, it can achieve high productivity, increased production, and greater efficiency.

The production function illustrates how much output can be produced with the available resources. These resources, also known as factors of production, can vary depending on the nature of production. Typically, three categories of production factors are recognized: labor, capital, and land. Since the land factor remains relatively constant, it is often excluded from the production function.

Solow (1957) defined the total productivity factor as the efficiency with which firms convert available resources into corresponding outputs, yielding appropriate results. The production function is further detailed at the sectoral level (4) (Lasagni et al., 2015).

$$Y_{it} = A_{it} K_{it}^{\alpha_k} L_{it}^{\alpha_l} M_{it}^{\alpha_m} \quad (4)$$

where:

Y_{it} - the sector's revenue;

A_{it} - specific time-variant term;

$K_{it}^{\alpha_k}$ - our measure of physical capital, namely the value of tangible fixed assets as reported in the balance sheet;

$L_{it}^{\alpha_l}$ - our measure of employment level;

$M_{it}^{\alpha_m}$ - raw materials expenditures.

It follows that three factors are included in the calculations - capital, labor and intermediate goods. As a measure of capital to include the value of machines, the use of technological resources, the value of vehicles and equipment, how work is evaluated as total compensation for employees (wages, rewards), and intermediate consumption goods are determined by raw materials and materials prices. These factors lead to explanations of factors of production that can be employed to create added value and increase technical efficiency. By monitoring these determinants, appropriate ways can be found to increase their productivity (Table 1).

Tab. 1 – The indicator marking. Source: own research

Indicators	Marking	Units
Employment	L_t	Thousand
Average annual capital	K_t	Mln. EUR
Gross domestic product	Y_t	Mln. EUR
Use of fixed capital	A_t	Mln. EUR
Labor productivity	p_L	-
Capital productivity	a_t	-

Considering the quantitative expression of the available data, the methodology for calculating the overall productivity factor is applied to the analysis. The formula (5) (using the analytical method) evaluates the performance of the factors considered in the gross domestic product.

$$\Delta Y_{TFP} = \Delta Y_{TFP/L} + \Delta Y_{TFP/K} \quad (5)$$

GDP growth is interpreted as paying the fixed costs of innovation in a perfectly competitive economy with constant returns to scale in capital and labor. In connection with GDP growth rate and innovations, it is necessary to consider the main components of GDP growth - capital and labor force indicators. Therefore, it is first necessary to calculate the growth rates of labor (6) and capital (7) and their impact on GDP.

$$\Delta Y_L = (L_t / L_{t-1} - 1) \times (Y_{t-1} - A_{t-1}) \quad (6)$$

where:

L_t / L_{t-1} - growth of the labor force utilization index;

Y_{t-1} - GDP in the previous period (at current prices);

A_{t-1} - use of capital in the previous period.

$$\Delta Y_K = (K_t / K_{t-1} - 1) \times A_{t-1} \quad (7)$$

where:

K_t / K_{t-1} - growth of capital utilization index;

Second, it is necessary to calculate GDP growth using labor and capital (8).

$$\Delta Y_{TFP} = \Delta Y - (\Delta Y_L + \Delta Y_K) \quad (8)$$

where:

ΔY - changes in GDP.

Maximizing benefits is choosing a combination of labor and capital that minimizes incurred costs and maximizes expected profits. Calculating the index requires three factors: GDP, labor and capital. Productivity is assessed through GDP/1 per inhabitant or working person (calculated according to purchasing power parity), where changes in size have a pronounced impact on the country's economy (Oyewole et al., 2024). The level and dynamics of GDP show

changes in labor productivity depending on several factors (e.g., volume and quality of physical capital, level of technology, efficiency and flexibility in work organization and management, etc.).

An economic downturn means lower profits and lower wages. The calculations require country data on gross value added, average annual fixed capital, use of fixed capital and average annual number of employed persons. The overall productivity factor is calculated for each country.

The assessment of competitiveness using the cointegration and the Granger causality tests

A review of findings from various scientific studies reveals that numerous researchers explore the interconnections between wages, inflation, price levels, employment, and competitiveness. These analyses increasingly incorporate advanced mathematical tools, with a recommendation to complement correlation-regression analysis with the Granger causality test for a more comprehensive understanding.

The Granger causality test is closely related to the vector autoregression (VAR) model (Götz et al., 2016). C. Granger (1969) presented the concept of causality, where it is stated that if there is a dependence of X on Y and knowing the past values of X and Y, it is possible to predict the trend of Y. The Granger causality test for time series assumes that if X affects Y, then changes in Y should be preceded by X changes, not vice versa (Danilenko, 2009). That is, the Granger causality test measures the causality between two variables, X and Y, and explains how much of the current values of Y can be explained by changes in the values of X while also considering the lag effect (Yousefi, 2015). Engle and Granger (1987) state that variables are cointegrated if they have a stochastic trend. Three variables are distinguished: total added value (Y_t - Eur/per 1 employed person), employment (X_1 - per person) and wages (X_2 - Eur/per 1 employed person).

Determining the cointegration of variables in the case of two-time series y_t and x_t , a regression equation is created (Vetlov, 2000):

$$y_t = \sum_{i=1}^k \alpha_i y_{t-i} + \sum_{i=1}^k \beta_i x_{t-i} - u_t \quad (9)$$

where u_t – “white noise” residuals.

From the condition that $\beta_i=0$ ($i=1,2,\dots,k$) is a statistically acceptable constraint, it follows that x_t is not the cause of y_t . This means that the Granger causality test determines the influence of past observations of one variable on the current value of another variable.

The concept of Granger causality relies on long-term observation of changes in variables and the ability to predict the values of variables based on the past values of other variables, thus indicating the direction of causality between factors (Chu et al., 2016). The results of the causality test are sensitive to external factors and time, so it is essential to select the appropriate number of lags based on an analysis of the relationship and causality of the variables (Yousefi, 2015). The Granger test utilizes the Wald test, which tests the significance of the number of lags for the second variable. This method can help determine the number of lags for equality in an autoregressive model of another variable, thereby improving predictions for the other variable (Bilen et al., 2017). The selection of lags must satisfy standard stationarity criteria, such as showing correlation, normal distribution, and homoscedasticity (Vetlov, 2000). In this

study, the Granger causality test was conducted with one, two, three, and four-period lags, as using lags helps reduce the impact of limited data on the results. A VAR delay method was applied to determine the optimal number of lags, and based on most criteria, the results presented are from four lags. The outcomes of the test depend on the conditional sampling frequency of the variables, the frequency of observations, the period length, and the reliability of the data (Götz et al., 2016). One limitation of this widely used econometric technique is that it cannot investigate causality at different data frequencies (Bilen et al., 2017).

When applying the Granger causality test, the regression equations of the vector autoregression model are created (Danilenko, 2009):

$$y_t = \alpha_0 + \sum_{i=1}^m \alpha_i y_{t-i} + \sum_{i=1}^m \beta_i x_{t-i} + \varepsilon_t \quad (10)$$

$$x_t = \alpha_0 + \sum_{i=1}^m \alpha_i x_{t-i} + \sum_{i=1}^m \beta_i y_{t-i} + u_t \quad (11)$$

where ε_t and u_t – are uncorrelated random errors (“white noise”).

Hypotheses were formed during testing. The null hypothesis states that X is not Granger-caused by Y, while the first hypothesis states that X is Granger-caused by Y. In this way, double relations between two variables are analyzed in different regressions, and the values of one variable are checked to determine whether they are informative enough to predict the values of the other variable. The F statistic is evaluated in joint hypothesis testing (the null hypothesis about the statistical significance of the coefficients is tested for each equation) (Danilenko, 2009).

$$\beta_1 = \beta_2 = \beta_3 = \dots = \beta_m = 0$$

Two hypotheses were formed for testing:

H₀: X is not Granger causal to Y, and the variables are not integrated.

H₁: X is Granger causal to Y, and the variables are cointegrated.

The VAR technique uses panel data and time series for hypothesis testing. One data series is used to predict relationships with the second, and the model’s point is that the null hypothesis is almost always correct. The essence of causality analysis is to assess whether Y affects X, whether X affects Y, and whether there is a dependency between X and Y. When investigating hypotheses, two conditions must be met (Danilenko, 2009): X should make a statistically significant contribution to the prediction of Y, and Y should not make a statistically significant contribution to the prediction of X.

The influence of X on Y indicates the possibility of causality, and rejecting the null hypothesis means that X is not the cause of Y. A significance level of 5% is chosen for hypothesis testing (Danilenko, 2009).

If the p-values remain higher than the chosen significance level ($\alpha=0.05$), it shows that the values of variable X are Granger-caused by Y. In this case, the null hypothesis that X is not a Granger cause of Y is rejected.

Other hypotheses have also been formed for the study:

If competitiveness increases, added value increases but is not redistributed enough for wage growth. The increase in turnover is faster, social development problems (lack of qualified labor force) are formed, and investments in human capital decrease.

To evaluate the relationships between wages, employment, and competitiveness presented in the theoretical model, it is necessary to identify the aspects of the country's competitiveness, analyze competitiveness factors, assess the percentage influence of capital and labor on overall productivity, and identify the relationship between wages, employment, and competitiveness.

This study consists of analyzing the dynamics of competitiveness, determining the relationship between wages, employment, and productivity, and assessing its strength. Before conducting the analysis, it is necessary to analyze the data required for the study and define the boundaries.

For the analysis results to be as accurate as possible, it is advisable to choose a more extended period of study. The effects of certain factors determining work productivity may only appear after a certain period, so the results obtained in a too-short period may be inadequate. The period 1995-2022 is selected for this study, and due to the lack of quarterly data statistics, annual data is used in the analysis. The choice of the beginning of the period is because, since 1995, the Eurostat (2022) database contains statistical data on the countries of the European Union.

For the study, the data collected by Eurostat were chosen because this database contains all the indicators required for the study and is adequate for the selected period. The end of the research period was determined by the fact that during the systematization of the results, the data for years after 2022 have not yet been published.

In summary, in order to empirically evaluate the relationships between wages, employment and productivity based on the theoretical level, it is necessary to do the following: use the global competitiveness index to perform an analysis of the dynamics of competitiveness to base the percentage effect of capital and labor on the total productivity of the country on the values of the aggregate productivity factor, to check the stationarity of the data time series, and to carry out a correlation analysis - regression analysis is necessary to determine (and to justify by applying the Granger causality test) the relationship between wages, employment and productivity and to evaluate its strength. The application of the Granger causality test is also attractive in that choosing an adequate number of lags for the actual situation allows for determining the lagged effects of wage and employment fluctuations on productivity.

4 RESULTS AND DISCUSSION

4.1. Results of calculation of global productivity factor

To clarify the essence of the percentage of capital and labor contribution to productivity, the method of calculating the global productivity factor is applied. As mentioned, the total productivity factor shows the efficiency of available labor and capital resources and its effect on labor results (profit or gross domestic product/total added value). The period from 1995 till 2022, which meets the most modern conditions, was chosen for the evaluation, and here the available fixed capital and how it is used, the number of employees, and the estimated impact of the available resources on productivity are analyzed.

Available resources have the most significant impact on productivity in Greece, Portugal and Estonia, which means that workers work efficiently and use available resources properly to increase the country's GDP. Based on the calculations, the weakest impact on GDP occurs in

Finland, Luxembourg and Latvia. Analyzing this situation differently, it is important to predict which countries' labor has the strongest influence on the total added value and which capital has the strongest influence (Figure 2).

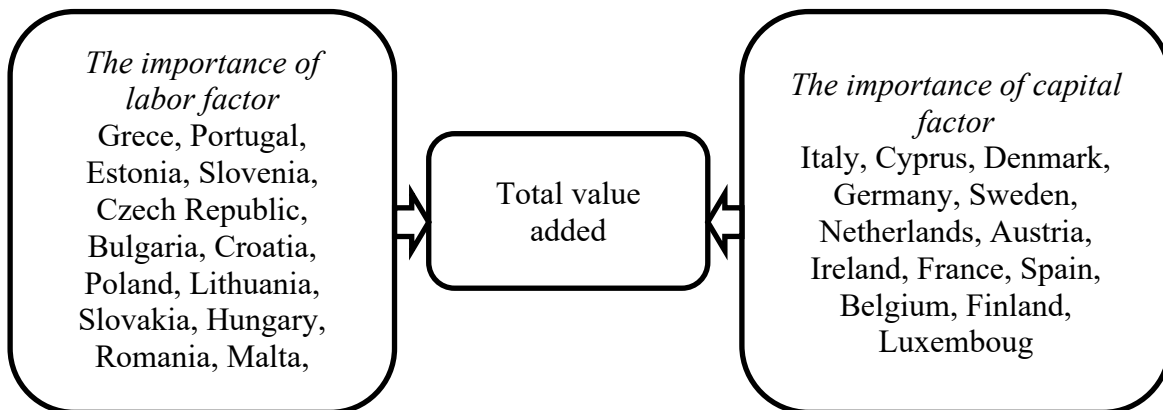


Fig. 2 – Distribution of countries according to the significance of labor and capital factors for the total added value. Source: compiled by the authors, based on their own calculations

A tendency also emerges that in the countries with the highest total value added (Greece, Portugal, Estonia and other countries except Italy and Cyprus) labor resources (in terms of the number of employed) have the most significant influence on this and their operational efficiency. In contrast, in low total value added countries (except Malta and Latvia), available capital has a pronounced effect on productivity. Changes in capital are inversely proportional to changes in productivity (Romania, Lithuania or Sweden): as capital resources decrease, productivity increases, which means that available capital is used more efficiently.

After performing the analysis in two sections, in terms of the strength of the connection (using correlation-regression analysis) and the direction of the connections (using the Granger causality test), all countries of the European Union are arranged in 4 groups according to the strength of the connection:

1. Very weak connection (Cyprus);
2. Weak connection (Ireland, Belgium, Netherlands);
3. Medium connection (Austria, Denmark, Latvia, Luxembourg, Malta, Slovakia, Finland);
4. Strong connection (Bulgaria, Czech Republic, Estonia, Greece, Spain, Italy, Croatia, Poland, Lithuania, Portugal, France, Romania, Slovenia, Sweden, Hungary, Germany).

A trend emerges that the mentioned factors have a significant influence in most countries (Bulgaria, Czech Republic, Estonia, and others).

Also, the results of the Granger causality test are used for predicting the direction of the relationships between the factors. E.U. countries and the impact of four main factors (employment, wages, capital and investment) on productivity and their interrelationships are analyzed. Two hypotheses are tested during the analysis:

H0: X is not Granger causal to Y, and the variables are not integrated.

H1: X is Granger causal to Y, and the variables are cointegrated.

A strong relationship exists if the probability is less than 0.05, and a moderate relationship is less than 0.10. Countries where the H1 hypothesis is confirmed, that the variables are Granger

causal and cointegrated, are highlighted. Wages and employment substantially impact competitiveness in Bulgaria, Denmark, Cyprus, France and Finland.

4.2. Clustering of E.U. countries and panel data analysis

After a detailed analysis of competitiveness, employment, wages, investments, capital and their interrelationships, it became possible to cluster the countries of the European Union under consideration according to the relevant characteristics (Table 2) and to prepare a panel data analysis for the analyzed groups of countries.

Tab. 2 – Competitiveness groups and their characteristics. Source: own research

High competitiveness groups and their characteristics	Characteristics	Countries
Group 1	High wage level	France
	High employment rate	
	High level of capital	
	High level of investment	
Group 2	High wage level	Ireland, Austria, Belgium, Denmark, Luxembourg, Netherlands, Finland, Sweden
	Low employment rate	
	High level of capital	
	High level of investment	
Group 3	Low wage level	Italy, Germany
	High employment rate	
	High level of capital	
	High level of investment	
Low competitiveness groups and their characteristics	Characteristics	Countries
Group 4	Low wage level	Spain
	Low employment rate	
	High level of capital	
	High level of investment	
Group 5	Low wage level	Bulgaria, Czech Republic, Estonia, Greece, Cyprus, Croatia, Latvia, Poland, Lithuania, Malta, Portugal, Romania, Slovakia, Slovenia, Hungary
	Low employment rate	
	Low level of capital	
	Low level of investment	

Table 2 shows that there are 3 groups of high productivity: Group 1 – all highly valued attributes; Group 2 – in case of low employment; Group 3 - at a low wage level and 2 low

productivity groups: Group 4 – at low levels of productivity, wages and employment and high levels of capital and investments; Group 5 - all low-valued attributes.

All groups have a strong effect of wages on productivity, which means that as wages increase, productivity and competitiveness also change accordingly. Therefore, to increase competitiveness, it is appropriate to invest effectively in increasing wages as a critical factor of efficiency. In the first group of countries, competitiveness also depends on the existing level of capital and the number of attracted investments. In the second group, investment has a moderate impact on competitiveness. In the fifth group, along with capital (which has a moderate effect on competitiveness), employment also has an impact.

After evaluating the strength of the connection between the mentioned factors (using correlation-regression analysis), 27 E.U. countries are organized into 4 groups according to the strength of the connection: very weak connection (Cyprus); weak connection (Ireland, Belgium, Netherlands); medium connection (Austria, Denmark, Latvia, Luxembourg, Malta, Slovakia, Finland); strong connection (Bulgaria, Czech Republic, Estonia, Greece, Spain, Italy, Croatia, Poland, Lithuania, Portugal, France, Romania, Slovenia, Sweden, Hungary, Germany). A trend emerges that in most countries (Bulgaria, Czech Republic, Estonia and others), the mentioned factors have a significant influence. A Granger causality test was used to determine the direction of factor relationships. The obtained results allow rejecting H_0 (X is not a Granger cause of Y, and the variables are not integrated) and accepting H_1 (X is a Granger cause of Y, and the variables are cointegrated). Wages and employment have the strongest impact on competitiveness in Bulgaria, Denmark, Cyprus, France and Finland. To assess the impact of wages, employment, investment and capital on competitiveness, considering the differences in the development of countries, E.U. countries are classified into five groups: three with high competitiveness and two with low competitiveness and changing other factors.

5 DISCUSSION

Competitiveness is a dynamic, multifaceted concept examined across various levels, including enterprises, regions, and countries (Yordan et al., 2017). Emerging in the 20th century, the concept initially focused on economic comparisons in the United States, defining competitiveness as surpassing rivals by offering goods and services under optimal conditions. Over time, the term has expanded to encompass productivity, innovation, and sustainability as critical components (Lotfi & Karim, 2016; Oyewole et al., 2024).

At its core, competitiveness refers to the ability to supply products and services efficiently, at competitive prices, while meeting quality and market demands. It is linked to sustainable living standards, economic growth, and the capacity to adapt to changing socio-economic conditions (Oyewole et al., 2024). Competitive advantage stems from using resources effectively, leveraging innovation, and creating favorable conditions for growth (Keil, 2024).

At the micro level, company competitiveness involves securing market share by producing quality goods and services tailored to market needs. Competitive success depends on minimizing costs, enhancing innovation, and strategically positioning in the market (Sudirjo, 2023; Sui et al., 2024). Companies utilize competitive potential, instruments, and advantages to maintain a favorable position and adapt to market demands.

At the macro level, competitiveness evaluates a country's ability to achieve sustained growth, high employment, and productivity through efficient resource use and favorable trade conditions (Porter, 1990). Key approaches include the following:

- Foreign trade: Enhancing export growth and international market share.
- Productivity: Promoting high standards of living through continuous productivity improvements.
- Well-being: Ensuring employment, social guarantees, and equitable growth.
- Globalization, technological advancements, and urbanization drive competitiveness by fostering the exchange of goods, services, and knowledge while creating new demands and opportunities. Regional competitiveness influences and is influenced by company-level performance, as both levels interact dynamically.

While company and country competitiveness are interconnected, they operate on different scales. Companies drive regional success, while regions and nations provide frameworks that shape business capabilities. Competitiveness, therefore, emerges from a synergy of economic, political, social, and infrastructural factors.

A correlation regression analysis was conducted to evaluate the strength of connections between factors influencing competitiveness across 27 E.U. countries. The countries were categorized into four groups based on the strength of these connections:

- **Very weak connection:** Cyprus
- **Weak connection:** Ireland, Belgium, Netherlands
- **Medium connection:** Austria, Denmark, Latvia, Luxembourg, Malta, Slovakia, Finland
- **Strong connection:** Bulgaria, Czech Republic, Estonia, Greece, Spain, Italy, Croatia, Poland, Lithuania, Portugal, France, Romania, Slovenia, Sweden, Hungary, Germany.

The analysis shows that in most countries (e.g., Bulgaria, Czech Republic, Estonia), these factors significantly influence competitiveness. Using the Granger causality test, the results confirmed cointegration between variables, allowing the rejection of H₀ (no causal relationship) and acceptance of H₁ (causal relationship exists).

Wages and employment were found to have the strongest impact on competitiveness, notably in Bulgaria, Denmark, Cyprus, France, and Finland. To further analyze the impact of wages, employment, investment, and capital on competitiveness, E.U. countries were divided into five groups: three with high competitiveness and two with low competitiveness, reflecting variations in their developmental levels and influencing factors.

6 CONCLUSION

In the modern, constantly changing and globalized world, the need to increase a country's competitiveness is becoming increasingly important. Competitiveness is described as a multifaceted, dynamic economic concept, which is related to the ability to adapt to the ever-changing socio-economic environment, defines the ability to earn, lead and compete with others for better performance at the level of capital, technical knowledge, or skills, while simultaneously working with quality and innovation. Based on the analysis, two factors with the greatest impact on competitiveness were singled out: technological development and human resources. Technological progress fundamentally changes people's habits. There is a constant need to improve, be interested in innovation and be receptive to innovation, as it encourages finding a solution related to increasing employment and changes in workplace flexibility. Technologically advanced countries can attract more foreign investments, and innovativeness is based on the ability of companies to apply innovations in products and decisions that depend on consumers. In economic added value creation, human capital becomes an essential lever ensuring the implementation of innovations and the application of innovative technologies. Human capital becomes the primary source of income and welfare growth. With the integration

of the economic and social subsystem, there is a purposeful and effective progress of social, economic and political development.

After analyzing the basic changes in the political, economic, social and technological environments and their impact on competitiveness at the conceptual level, the conclusion was reached that the level of wages and the scope of employment should form the basis for the creation of a model for assessing the impact of factors determining the growth of competitiveness. By including other important competitiveness factors in the model, assumptions are made to systematically assess the interrelationships of these factors and their impact on productivity both at the level of a country and a group of countries.

After assessing the strength of the connection between such factors (using correlation-regression analysis), E.U. countries are organized into 4 groups according to the strength of the connection. The group with a strong connection includes Lithuania, Bulgaria, the Czech Republic, Estonia, Greece, Spain, Italy, Croatia, Poland, Portugal, France, Romania, Slovenia, Sweden, Hungary, and Germany). The obtained Granger causality test results allow rejecting H_0 (X is not a Granger cause of Y, and the variables are not integrated) and accepting H_1 (X is a Granger cause of Y, and the variables are cointegrated). From the obtained results, it can be seen that in order to ensure the growth of competitiveness, more attention and financial resources should be devoted to the growth of the wage level, because then the motivation of employees to work productively will be encouraged and, accordingly, companies will not go bankrupt, and therefore the level of employment will also increase. Only then will the best conditions be created for the growth of the competitiveness of both the company and the country.

This study also acknowledges several limitations and suggests directions for future research:

- Methods: The Granger causality test, correlation-regression analysis, and productivity factor were used in this research. Future studies could expand the range of methods employed, incorporating techniques like multivariate analysis and others.
- Factors: This study focused on the relationship between competitiveness, wages, and employment. Future research could explore additional factors, such as inflation, unemployment, and other economic variables.
- Time: Future studies could extend the analysis over a longer period to potentially yield different results.

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Contact information

prof. Dr Laima Okunevičiūtė Neverauskienė

Vilnius Gediminas Technical University

Faculty of Business Management

Department of Economics Engineering

Lithuania

E-mail: Laima.Okuneviciute.Neverauskiene@vilniustech.lt

ORCID: <https://orcid.org/0000-0002-7969-3254>

prof. Dr Romualdas Ginevičius

Vilnius Gediminas Technical University

Faculty of Business Management

Institute of Dynamic Management

Lithuania

E-mail: Romualdas.Ginevicius@vilniustech.lt

ORCID: <https://orcid.org/0000-0003-2067-4398>

Assoc. prof. Dr Irena Danilevičienė

Vilnius Gediminas Technical University

Faculty of Business Management

Department of Financial Engineering

Lithuania

E-mail: Irena.Danileviciene@vilniustech.lt

ORCID: <https://orcid.org/0000-0003-1943-4135>