SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2024
ORGANIZATION AND MANAGEMENT SERIES NO. 209

DETERMINANTS OF THE ECONOMIC DEVELOPMENT OF THE VISEGRAD GROUP COUNTRIES

Kinga BEDNARZEWSKA

Maria Curie-Sklodowska University; kinga.bednarzewska@mail.umcs.pl, ORCID: 0000-0002-5786-928X

Purpose: The research purpose of this article was to identify selected variables that influence the overall level of economic development of the Visegrad Group countries.
Design/methodology/approach: The article uses qualitative and quantitative research methods. A review of Polish and foreign literature on the subject was conducted, and secondary data (desk research) was analyzed based on public statistical data presented in time series (Eurostat, OECD, The World Bank) covering the period 2017-2024. To indicate the relationships between variables, a statistical analysis was performed using linear regression using the Stepwise method.
Findings: The article presents selected macroeconomic factors that affect the level of economic development of the Visegrad Group countries. The analysis of the interdependencies between these factors allowed for a deeper understanding of the relationships between variables.
Originality/value: The influence of selected macroeconomic factors conditioning the economic development of the Visegrad Group countries was verified using linear regression analysis. The literature review allowed the author to diagnose the research gap in the scope of the indicated determinants of the economic development of the V4 Group countries.
Keywords: Visegrad Group, economic development, GDP, minimum wages, Annual Enterprise Statistics for Special Aggregates of Activities, unemployment, mobile students, graduates.
Category of the paper: research paper.

1. Economic development

The level of economic development is an essential factor influencing the quality of life of a society. In highly developed economies, the situation in the labor market is generally stable, the population's average income level is high, and the financial crisis of households is good (Pastuszka, 2020). Economic development is a long-term process encompassing changes in the economy. Economic development encompasses qualitative changes (including changes in the organization of societies). Economic development is analyzed in three areas. First, in the substantive aspect, which is expressed, for example, in the faster growth of the

processing industry than the mining industry or the faster growth of the consumer services sector compared to the growth of the entire sphere of material production. Secondly, economic development can be analyzed in terms of ownership, expressed in the emergence of state and municipal ownership, in the growing share of large corporations in the total capital stock, e.g., in the emergence of an increasing number of international corporations. Thirdly, economic development is considered through the institutional prism (related to the growing role of state institutions, the state budget, and the banking system and capital market in the functioning of the national economy) (Chojnacka, 2020).

The main indicators of the level of economic development include:

1) GDP and national income per capita,
2) production of the main types of products per capita (electricity, basic foodstuffs - grain, milk, meat, sugar, potatoes, etc.,
3) sectoral structure of the national economy: relationships between national economic sectors of material and non-material production,
4) the level and quality of life of the population (analysis of the consumption basket, subsistence minimum),
5) indicators of economic efficiency of production (Khudoyarov et al., 2024).

It should be noted that the most common indicator that determines the level of economic development and is used in international comparisons is the gross domestic product per capita (GDP). This is a measure defining the value of goods and services produced in the economy of a given country in a given time (e.g., during a year), divided by the number of its inhabitants (per capita) (Knapińska et al., 2024).

The level of economic development between countries and even regions is significantly different (Wojtyna, 2007). These results, among other things, stem from the availability of production factors, which, in the theory of classical economics, can be divided into three main categories: land, capital, and labor (Hollander, 2005). Also in the context of the definition of economics, the essence of which is the management of limited resources (Samuelson, Nordhaus, 2012), it can be noticed that the barrier to unlimited economic development is the limited resources, which makes it impossible to satisfy all needs to the same extent (Żylicz, 2004; Grzelak, Matuszczak, 2011; Genstwa, 2022).

2. Visegrad Group Countries

The Visegrad Group is an informal regional cooperation associated with four Central and Eastern European countries: Poland, the Czech Republic, Slovakia, and Hungary (Braun, 2020). It was established on 15 February 1991 in the Hungarian castle in Visegrad, during a meeting of three representatives from each country (Olszyk, 2024). The V4 Community is a platform

for the integration of countries with similar geopolitical conditions, shared history, tradition, culture, and values characterized by a comparable level of socio-economic development. The V4 Group is a platform for creating initiatives and conducting activities in such areas as political and economic cooperation, security and defense, cultural and educational cooperation, and regional and cross-border cooperation (Jasiecki, 2020).

The Visegrad Group countries also focus on the constant transfer of values in the areas of culture, education, and science between the countries of the group (Sobczak et al., 2021). The Visegrad Group (Đurović Todorović et al., 2024) aims to contribute to building European security based on cooperation and coordination within existing European and transatlantic institutions (Visegrad Group, 2023). These economies are considered an example of a successful transition from a centrally planned economy to a market economy (Bieszk-Stolorz, Dmytrów, 2020).

From the Polish perspective, the Visegrad Group was one of the most important arenas of regional cooperation, although this significance changed radically after the Ukraine war outbreak. This was a consequence of Hungary presenting a radically different vision (from the other three) regarding the course, assessment, and postulated end of the Russian aggression against Ukraine. During the Slovak (2022/2023) and Czech (2023/2024) presidencies in the Visegrad Group, the frequency of organizing summits at higher political levels decreased significantly (Héjj, 2023).

3. Analysis of selected macroeconomic factors

Due to the numerous socio-cultural similarities and similar geopolitical situation of Poland, the Czech Republic, Slovakia, and Hungary, it was justified for the Author to conduct an analysis of the relationship between the level of GDP per capita and selected macroeconomic factors for the V4 countries. In this study, the Author focused on seven factors such as:

- Gross Domestic Product (GDP) – is one of the most important indicators used to measure the level of economic development of a given country, constituting a useful point of reference in determining the production capacity and efficiency of the economy (Watanabe et al., 2018; Ramzan et al., 2019).
- Minimum wage – „Minimum wages have been defined as the minimum amount of remuneration that an employer is required to pay wage earners for the work performed during a given period, which cannot be reduced by collective agreement or an individual contract" (International Labour Organization, 2024).
- Annual Enterprise Statistics for Special Aggregates of Activities (AES-AG) – the term „refers to a dataset and methodology used within the framework of Structural Business Statistics (SBS) in the European Union. It includes detailed annual data on enterprise

characteristics such as the number of enterprises, turnover, employment, and investment across various industries classified under the NACE (Statistical Classification of Economic Activities) system". These statistics are essential for analyzing different economic sectors' structure, performance, and dynamics, excluding agriculture and largely non-market services such as education and health (European Union, 2024).

- Unemployment – „Unemployment rates represent unemployed persons as a percentage of the labor force. The labor force is the total number of people employed and unemployed" (Eurostat, 2024).
- Population total - population is the number of people that live in a country. It counts the resident population, defined as all nationals present in, or temporarily absent from the country, and aliens permanently settled in the country (OECD, 2024).
- Share of mobile students from abroad enrolled by education level, sex and country of origin, tertiary education, sex total in %.
- Graduates by education level, program orientation, completion, sex, and age: total, tertiary education (% of population total).

Table 1 presents selected macroeconomic factors determining the economic development of the Visegrad Group countries. Statistical data are presented in time series (2017-2024).

Table 1.
Selected indicators characterizing the Visegrad Group countries in 2017-2024

Country	**Time**							
Slovakia	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
GDP per capita (current US$)	17585,2	19486,39	19383,48	19545,74	21391,93	21258,1	24470,2	bd
Minimum wages (Euro)	435	480	520	580	623	646	700	750
Population total	5439232	5446771	5454147	5458827	5447247	5473197	5518055	5506760
AES-AG*	471691	493636	512082	518497	bd	bd	bd	bd
Unemployment (% of total labor force)	8,13	6,54	5,75	6,69	6,83	6,14	5,8	bd
Share of mobile students from abroad enrolled by education level, tertiary education, sex total in %	4,4	4,5	4,6	4,8	4,6	4,8	bd	bd
Graduates by education level, program orientation, completion, sex and age: total, tertiary education	50622	44467	40324	38548	39514	37420	bd	bd

Cont. table 1.

Poland	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
GDP per capita (current US$)	13815,62	15504,58	15699,91	15816,99	17999,91	18321,3	22112,9	bd
Minimum wages (Euro)	464	502,75	523,09	610,79	614,08	654,79	745,60	977,53
Population total	37974826	37974750	37965475	37899070	37747124	38385739	38762,844	38539201
AES-AG*	1 744 285	1 960 361	2 022 248	2 066 209	bd	bd	bd	bd
Unemployment (% of total labor force)	4,89	3,85	3,28	3,16	3,36	2,88	2,90	bd
Share of mobile students from abroad enrolled by education level, tertiary education, sex total in %	0,5	0,4	0,4	0,4	0,5	0,5	bd	bd
Graduates by education level, program orientation, completion, sex, and age: total, tertiary education	517305	469992	452628	411534	403602	400168	bd	bd
Hungary	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
GDP per capita (current US$)	14621,24	16425,1	16782,95	16120,99	18728,12	18463,2	22147,2	bd
Minimum wages (Euro)	412,91	444,69	464,2	487,1	442,44	541,73	578,74	696,97
Population total	9787966	9775564	9771141	9750149	9709891	9684306	9686463	9676135
AES-AG*	570005	599547	647091	668796	bd	bd	bd	bd
Unemployment (% of total labor force)	4,16	3,71	3,42	4,25	4,05	3,60	4,1	bd
Share of mobile students from abroad enrolled by education level, tertiary education, sex total in %	3,9	3,9	4	4	3,6	3,9	bd	bd
Graduates by education level, program orientation, completion, sex, and age: total, tertiary education	63109	65079	62715	177972	71480	59471	bd	bd
Czech republic	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
GDP per capita (current US$)	20636,2	23424,48	23664,85	22992,88	26821,25	27638,4	30427,4	bd
Minimum wages (Euro)	407,00	477,78	518,97	574,62	579,22	651,70	717,37	764,44
Population total	10594438	10629928	10671870	10697858	10505772	10673213	10809716	10735859
AES-AG*	1 019 773	1 043 330	1 058 776	1 068 446	bd	bd	bd	bd
Unemployment (% of total labor force)	2,89	2,24	2,01	2,55	2,81	2,22	2,60	bd
Share of mobile students from abroad enrolled by education level, tertiary education, sex total in %	7,3	7,7	8	8	7,8	7,6	bd	bd
Graduates by education level, program orientation, completion, sex, and age: total, tertiary education	87131	76158	72714	70119	67367	66746	bd	bd

bd – no data available.

„*" - Annual enterprise statistics for special aggregates of activities

Source: own study based on Eurostat, https://ec.europa.eu/eurostat/data/database, OECD https://data.oecd.org/, The World Bank, https://data.worldbank.org/, 28.11.2024.

Table 2 presents the dynamics of changes in the values of indicators year-on-year for the Visegrad Group countries. The list was prepared in percentage terms, assuming that the same period of the previous year = 100.

Table 2.
Dynamics of changes in indicator values for the Visegrad Group countries in 2017-2024 (%), the same period of the previous year = 100

Country	y/y	*2018/2017*	*2019/2018*	*2020/2019*	*2021/2020*	*2022/2021*	*2023/2022*	*2024/2023*
Slovakia	GDP per capita	110,81	99,47	100,83	109,44	99,37	115,11	bd
	Minimum wages	110,34	108,33	111,53	107,41	103,69	108,35	107,14
	Population total	100,13	100,13	100,08	99,78	99,78	100,81	99,79
	AES-AG	104,65	103,73	101,25	bd	bd	bd	bd
	Unemployment	80,44	87,92	116,35	102,09	89,90	94,46	bd
	Share of mobile students from abroad (%)	102,27	102,22	104,34	95,83	104,34	bd	bd
	Graduates, tertiary education	87,84	90,68	95,59	102,50	94,70	bd	bd
Poland	GDP per capita	112,22	101,26	100,75	113,80	101,79	120,69	bd
	Minimum wages	108,35	104,04	116,76	100,53	106,62	113,86	131,10
	Population total	99,99	99,97	99,82	99,59	101,69	100,98	99,42
	AES-AG	112,38	103,15	102,17	bd	bd	bd	bd
	Unemployment	78,73	85,19	96,34	106,32	85,71	100,69	bd
	Share of mobile students from abroad (%)	80	100	100	125	100	bd	bd
	Graduates, tertiary education	90,85	96,30	90,92	98,0	99,14	bd	bd
Hungary	GDP per capita	112,33	102,17	96,05	116,17	98,58	119,95	bd
	Minimum wages	107,69	104,38	104,93	90,83	122,44	106,83	120,42
	Population total	99,87	99,95	99,78	99,58	99,73	100,02	99,89
	AES-AG	105,18	107,92	103,35	bd	bd	bd	bd
	Unemployment	89,18	92,18	124,27	95,29	88,88	113,88	bd
	Share of mobile students from abroad (%)	100	102,56	100	90	108,33	bd	bd
	Graduates, tertiary education	103,12	96,36	283,78	40,16	83,19	bd	bd

Cont. table 2.

Czech Republic	GDP per capita	113,51	101,02	97,16	116,65	103,04	110,09	Bd
	Minimum wages	117,39	108,62	110,72	100,80	112,51	110,07	106,56
	Population total	100,33	100,39	100,24	98,20	101,59	101,27	99,31
	AES-AG	102,31	101,48	100,91	bd	bd	bd	bd
	Unemploy-ment	77,50	89,73	126,86	110,19	79,00	117,11	bd
	Share of mobile students from abroad (%)	105,47	103,89	100	97,5	97,43	bd	bd
	Graduates, tertiary education	87,40	95,47	96,43	96,07	99,07	bd	bd

bd – no data available.

Source: own study based on Eurostat, https://ec.europa.eu/eurostat/data/database, OECD https://data.oecd.org/, The World Bank, https://data.worldbank.org/, 28.11.2024.

Among the four Visegrad Group countries (2017-2024 y/y), the GDP per capita dynamics indicator showed an upward trend in all periods only in Poland, ranging from 100.75% to 120.69%. A decline in the GDP per capita dynamics was noticeable in 2020/2019 in Hungary (96.05%) and the Czech Republic (97.16%), while in 2022/2021, only Hungary (98.58%) and Slovakia (99.37%) noted a downward trend in this indicator. The year 2023 ended with the following results for the Czech Republic: 30427.4, Slovakia 24470.2, Hungary 22147.2, and Poland 22112.9 GDP per capita (current US$). In 2023, a negative natural increase was recorded in all the countries analyzed.

The minimum wage dynamics index in three V4 countries – Poland, Slovakia, and the Czech Republic – continuously showed an upward trend in the period (2017-2024 y/y), while in the 2021/2020 perspective, a negative value of the minimum wage dynamics index was recorded only in Hungary (90.83%). The total population dynamics index in the Visegrad Group countries (2017-2021 y/y) was a constant downward trend only in Poland and Hungary. In the Czech Republic and Slovakia, in the period (2017-2020 y/y), a minimal upward trend of this index was observed; however, in both countries in 2021, this trend changed towards a negative natural increase.

The AES-AG dynamics indicator in four V4 countries in the period (2017-2020 y/y) reached a positive value. However, a slight slowdown in this upward trend is observed in all countries. The unemployment dynamics indicator in all V4 countries (2017-2024 y/y) fluctuated, reaching an upward and downward trend. The lowest unemployment in 2023 was recorded in the Czech Republic and Poland. It is worth noting that over the 8 years counted from 2017, the unemployment rate in all Visegrad Group countries remained moderate.

The share of mobile students from abroad (%) in the analyzed period is an upward trend, except for the Czech Republic in 2021-2022 (fluctuations from 97.5 to 97.43%).

The graduates in tertiary education indicator were in a downward trend for the Czech Republic (2020-2022). The most considerable fluctuations in the indicator were recorded in Hungary, in 2019-2020, where in 2019/2020 it increased to 283.78%, and in the next period 2020/2021 it dropped to 40.16%.

The analysis of the dynamics of selected indicators for the Visegrad Group countries (Table 2) does not include a detailed discussion of the causes of their variability due to the variety of micro- and macroeconomic conditions. The COVID-19 pandemic, which affected the V4 countries in 2020, and the specificity of the socio-economic policy pursued at that time undoubtedly had a significant impact on the values of these indicators. The dynamics of economic transformations towards energy transformation (Jonek-Kowalska, 2024) in the V4 group towards a zero-emission economy (Łącka et al., 2024) also determines socio-economic development. However, these topics require separate, more in-depth studies to understand their significance fully.

4. Methods

The research objective of this article was to identify selected variables that affect the overall level of economic development of the Visegrad Group countries. Qualitative and quantitative research methods were used to achieve the objective. A review of Polish and foreign literature on the subject was conducted. Secondary data (desk research) was analyzed based on public statistical data (Eurostat, OECD, The World Bank) covering the period 2017-2024. In order to verify the impact of the group of factors determining economic development (GDP per capita current US$), a dependency analysis was conducted using the linear regression function.

The regression function (Ali, 2021) is a tool for studying the relationships between variables. The regression function is an analytical expression of assigning the mean values of a dependent variable to specific values of an independent variable. Linear regression assumes the relationship between the dependent and explanatory variables is linear. In linear regression, it is assumed that an increase or decrease in the other variable accompanies an increase in one predictor variable. Mathematically, the simplest form of linear regression is described by the equation $\boldsymbol{Y=\beta_0+\beta_1 X+\epsilon}$, where $\boldsymbol{Y}$ is the dependent variable, $\boldsymbol{X}$ is the independent variable, $\boldsymbol{\beta_0}$ is the intercept, $\boldsymbol{\beta_1}$ is the regression coefficient, and $\boldsymbol{\epsilon}$ is the random error. Regression uses methods such as least squares to minimize the deviations between data points and a linear model. A regression function is a mathematical function of a specific form that approximates the actual relationship between variables. The form of the function is determined based on the observed values ($\boldsymbol{x_i, y_i}$) (Stanisz, 2006, 2007).

The author conducted a regression analysis using independent variables such as:

- minimum wages (Euro),
- population total,
- Annual Enterprise Statistics for Special Aggregates of Activities (AES-AG) about population total (the indicator was created at the stage of statistical calculations in order to enable comparison between countries),
- unemployment, total (% of total labor force),
- share of mobile students from abroad enrolled by education level, sex and country of origin, tertiary education, sex total, in % - after estimation,
- graduates in tertiary education (% of population total – the indicator was created at the stage of statistical calculations in order to enable comparison between countries).

In order to indicate the relationship between variables, an analysis was carried out using the stepwise linear regression method (Hayes, 2022) (Stepwise method). The focus was on explaining the percentage of variability of the dependent variable (dependent variable), which is explained by the variability of the predictor. The linear regression analysis aimed to calculate such coefficients so that the model would best predict the value of the dependent variable, and the estimation error was as small as possible. Regression analysis fits such a straight line to the subjects, creating a linear relationship to burden the model with the slightest possible random error. The stepwise method was used, which is a variety of regression analysis in which only statistically significant variables, called predictors, are introduced to the model, improving the built model's quality. The GDP per capita indicator (current US$) was assumed as the dependent variable.

5. Results

In order to verify the influence of the group of factors conditioning economic development (GDP per capita), a dependency analysis was conducted. The results of the linear regression analysis are presented in Table 3, where the model's fit to the data is visible, and in Table 4, where the analysis of variance and regression coefficients are visible (Table 5). Four models were obtained. Predictors were introduced to each of them. Their statistical significance was checked.

Table 3.
Model fitting to the data

Model	R	*R Square (R^2)	Adjusted *R Square	Std. Error of the Estimate	Durbin-Watson
Predictors: (Constant), % - Annual enterprise statistics for special aggregates of activities/population total, unemployment, total (% of the total labor force) (modeled ILO estimate), minimum wages (EURO), the share of mobile students from abroad enrolled by education level, sex, and country of origin (tertiary education), sex total in % - after estimation	,967	0,935	0,922	1025,565264372120	
Predictors: (Constant), unemployment, total (% of the total labor force) (modeled ILO estimate), minimum wages (EURO), the share of mobile students from abroad enrolled by education level, sex, and country of origin (tertiary education), sex total in % - after estimation	,964	0,930	0,919	1039,743735283530	
Predictors: (Constant), minimum wages (EURO), the share of mobile students from abroad enrolled by education level, sex and country of origin (tertiary education), sex total in % - after estimation	,959	0,920	0,913	1081,788079437530	
Predictors: (Constant), minimum wages (EURO), the share of mobile students from abroad enrolled by education level, sex and country of origin (tertiary education), sex total in % - after estimation, %, graduates % of population total	,968	0,938	0,928	981,345227751106	2,113

*R2 is a measure of the quality of model fit. It is a measure of what percentage of the variability in the dependent (explained) variable is explained by the independent variable (factor, explanatory variable, predictor) or the statistical model.

Source: own study.

Table 4.
Analysis of variance – Anova

Model		Sum of Squares	df	Mean Square	F*	p-value
1	Regression	288653779,740	4	72163444,935	68,611	<,001
	Residual	19983898,118	19	1051784,111		
	Total	308637677,858	23			
2	Regression	287016337,157	3	95672112,386	88,498	<,001
	Residual	21621340,701	20	1081067,035		
	Total	308637677,858	23			
3	Regression	284062103,433	2	142031051,717	121,367	<,001
	Residual	24575574,425	21	1170265,449		
	Total	308637677,858	23			
4	Regression	289376908,738	3	96458969,579	100,161	<,001
	Residual	19260769,121	20	963038,456		
	Total	308637677,858	23			

*ANOVA – analysis of variance

Source: own study.

Table 5.
Regression coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value***
		B*	Std. Error	Beta**		
1	(Constant)	2981,864	1643,299		1,815	0,085
	% - Annual enterprise statistics for special aggregates of activities/ population total	525,590	421,238	0,288	1,248	0,227
	Unemployment, total (% of total labor force) (modeled ILO estimate)	-397,923	194,729	-0,183	-2,043	0,055
	Minimum wages (EURO)	20,670	3,706	0,442	5,578	0,000
	Share of mobile students from abroad enrolled by education level, sex, and country of origin (tertiary education, sex total, d - definition differs (see metadata), in % - after estimation	743,197	312,843	0,540	2,376	0,028
2	(Constant)	3047,390	1665,167		1,830	0,082
	Unemployment, total (% of total labor force) (modeled ILO estimate)	-215,381	130,290	-0,099	-1,653	0,114
	Minimum wages (EURO)	23,783	2,778	0,508	8,560	0,000
	Share of mobile students from abroad enrolled by education level, sex, and country of origin (tertiary education, sex total, d - definition differs (see metadata), in % - after estimation	1120,098	82,514	0,814	13,575	0,000
3	(Constant)	1906,235	1576,612		1,209	0,240
	Minimum wages (EURO)	24,098	2,884	0,515	8,356	0,000
	Share of mobile students from abroad enrolled by education level, sex, and country of origin (tertiary education, sex total, d - definition differs (see metadata), in % - after estimation	1141,088	84,828	0,829	13,452	0,000
4	(Constant)	-1485,357	2032,206		-0,731	0,473
	Minimum wages (EURO)	23,121	2,649	0,494	8,728	0,000
	Share of mobile students from abroad enrolled by education level, sex, and country of origin (tertiary education, sex total, d - definition differs (see metadata), in % - after estimation	1372,007	124,835	0,997	10,991	0,000
	% - graduates % of population total	3507,979	1493,259	0,215	2,349	0,029
a. Dependent Variable: GDP per capita (current US$).						

* Coefficient B – unstandardized regression coefficient.
** Coefficient Beta – standardized regression coefficient.
*** If the statistical significance of the F statistic is less than the generally accepted 0.05, it can be assumed that the model fits the data well.

Source: own study.

As a result of the analysis, four models were obtained. Each is well-fitted to the data, as indicated by the R2 coefficient (Table 3).

The first model is well-fitted to the data ($R^2 = 0.935$). It is built from predictors such as *Annual enterprise statistics for special aggregates of activity* about the *total population*, *unemployment* about the total labor force, *minimum wage* expressed in Euro, the percentage *share of mobility of students from abroad by higher education level, gender and country*, and the dependent variable which is *GDP per capita* (current US$) F (4, 23) = 68.611 p < 0.001. Based on the regression coefficients (Table 3), it can be concluded that the increase in *Annual enterprise statistics for special aggregates of activity* (beta = 0.288, p < 0.227), the decrease in the *unemployment level* (beta = -0.183, p < 0.055), the increase in the *minimum wage (EURO)* (beta = 0.442, p < 0.000) and the increase in the *mobility of students in higher education* (beta = 0.540, p < 0.028) increase the overall economic growth of the country. The obtained model explains 93% of the variability of economic development, which means that based on the model, it is possible to predict what factors shape the country's economic development. The regression equation has been written in the following form:

$$Y = 2981{,}864+525{,}590*X_{\text{Annual enterprise statistics for special aggregates of activity}} -397{,}923*X_{\text{Unemployment}} + 20{,}670*X_{\text{Minimum wages}} + 743{,}197*X_{\text{Share of mobile students}}$$

The second model was built with predictors such as *unemployment*, *minimum wage*, and student mobility, and the dependent variable, which is *GDP per capita* (current US$) F(3, 23) = 88.498, p < 0.001. This model fits the data well ($R^2 = 0.930$). Based on the regression coefficients (Table 3), it can be stated that the decrease in *unemployment* (beta = -0.099, p < 0.114, the increase in the *minimum wage (EURO)* (beta = 0.508, p < 0.000), and the increase in *student mobility* in higher education (beta = 0.814, p < 0.000) increase the overall economic growth of the country. The obtained model explains 93% of the variability of economic development, which means that based on the model, it is possible to predict what factors shape the country's economic development. The regression equation was written in the following form:

$$Y = 3047{,}390 - 215{,}38*X_{\text{Unemployment}} + 23{,}783*X_{\text{Minimum wage}} + 1120{,}098*X_{\text{Share of mobile students.}}$$

The third model was built with predictors such as minimum wage expressed in Euro, percentage share of international student mobility by higher education level, gender, and country, and the dependent variable, which is *GDP per capita* (current US$), F(2, 23) =121.367, p < 0.001. This model fits the data well (R2 = 0.920), and all variables are statistically significant. Based on the regression coefficients (Table 3), it can be stated that the increase in *student mobility* in higher education (beta = 0.829, p < 0.000) and the increase in the *minimum wage* (beta = 0.515, p < 0.000) increases the overall economic growth of the country. The obtained model explains 92% of the variability of economic development, which means that based on the model, it is possible to predict what factors shape the country's economic development. The regression equation was written in the following form:

$$Y = 1906{,}235+24{,}098*X_{\textit{minimum wages}} + 1141{,}088\ _{\textit{Share of mobile students.}}$$

The fourth model was built with the predictors of the *minimum wage* expressed in Euro, the percentage of international *student mobility* by higher education level, gender and country, and the percentage of *graduates*. The dependent variable in the model is *GDP per capita* (current US$) F (1,100) = 100.161, p < 0.001. This model fits the data well (R^2 = 0.935). All variables in the model are statistically significant. Based on the regression coefficients (Table 3), it can be concluded that the increase in the *minimum wage* (EURO) (beta = 0.494, p < 0.000), the increase in *student mobility* in higher education (beta = 0.997, p < 0.000), and the increase in the percentage of *graduates* (beta = 0.215, p < 0.029) increase the overall economic growth of the country. The obtained model explains 93% of the variability of economic development, which means that the model can be used to predict what factors shape the country's economic development. The regression equation was written in the following form**:**

$Y = -1485{,}357 + 23{,}121*X_{\text{Minimum wages}} + 1372{,}007*X_{\text{Share of mobile students}} + 3507{,}979*X_{\text{Graduates.}}$

6. Discussion

The article examines the influence of selected variables on the economic development of the Visegrad Group countries. Using regression analysis, it was checked which independent variables significantly influence the explained variable (GDP per capita). The conducted research shows that the economic development of the Visegrad Group countries is influenced by: *minimum wage (Euro), annual enterprise statistics for special aggregates of activities*, u*nemployment*, total (% of total labor force), *population total*, share of *mobile students* from abroad enrolled by education level, sex and country of origin, tertiary education, *graduates* in tertiary education.

The Visegrad Group (V4), which includes Poland, the Czech Republic, Slovakia, and Hungary, has undergone a significant economic transformation since the 1990s, characterized by dynamic economic growth, reduced unemployment, and an increase in the standard of living of its inhabitants. Analysis of indicators such as GDP per capita, unemployment rate, minimum wage, share of international students, number of university graduates, total population, and number of enterprises allows for a better understanding of the mechanisms of economic development in the region.

GDP per capita in the V4 countries is growing steadily, approaching the EU average, although the differences between countries remain clear. The Czech Republic has the highest GDP per capita in the region, which indicates greater economic efficiency compared to other countries in the group. The unemployment rate has gradually decreased in recent decades, and the Czech Republic has the lowest rate in the EU. The increase in the minimum wage

indicates an improvement in living conditions, but it is still lower than in Western EU countries, which attracts investors looking for cheaper labor.

The share of international students in the region is growing, especially in Poland and Hungary, possibly due to competitive costs and quality of education. The number of university graduates indicates an increase in human capital, although there is still a need for better integration of graduates into the labor market. The number of enterprises in the region is growing, indicating an improved investment climate and increased entrepreneurial activity. The total population plays a key role in determining the size of the domestic market, although in some V4 countries low population growth and labour emigration remain a challenge.

7. Summary

GDP growth per capita is the essential measure of economic development, but its dynamics in the V4 countries results not only from the economy's efficiency, but also from transfers of EU funds and investment strategies. Decreasing unemployment results from the inflow of foreign investments and relatively low labor costs, which supports the development of the industrial sector but may limit innovation and the transition to a knowledge-based economy.

The minimum wage serves two functions: it increases household incomes, but it can also limit the region’s price competitiveness in the future. The growth in the number of international students and university graduates is an opportunity to increase human capital, but it is necessary to strengthen the mechanisms for retaining talent in the region to prevent brain drain. The population and number of enterprises determine the scale of the economy, with the development of the SME (small and medium-sized enterprise) sector in the V4 remaining crucial to increasing innovation and diversifying the economy. Labor emigration and an aging population can limit the growth potential, which is why demographic and migration policies should be a priority.

The economic development of the Visegrad Group is based on the synergy between improving living conditions, education, entrepreneurship, and investment. Key challenges include reducing regional inequalities, integrating the economy with global trends, and ensuring sustainable growth through investment in innovation and human capital. The issues raised in this article provide prospects for conducting extended research in this area, which will be the subject of further research by the Author.

References

1. Adam, H., Khadija, K., Suzanne, K. (2022). *Stepwise Regression: Definition, Uses, Example, and Limitations.* Investopedia.
2. Ali, P., Younas, A. (2021). Understanding and interpreting regression analysis. *Evidence-Based Nursing, 24(4),* 116-118.
3. Bieszk-Stolorz, B., Dmytrów, K. (2020). Influence of Accession of the Visegrad Group Countries to the EU on the Situation in Their Labour Markets. *Sustainability, 12,* 6694 [CrossRef].
4. Braun, M. (2020). Postfunctionalism, identity and the Visegrad group. *Journal of Common Market Studies, Vol. 58, Iss. 4,* pp. 925-940, https://doi.org/10.1111/jcms.12994.
5. Chojnacka, K.J. (2020). Ekonomia społeczna w Polsce a rozwój gospodarczy. *Studia Prawno-Ekonomiczne, 116,* 157-179.
6. Đurović Todorović, J., Đorđević, M., Mirović, V., Kalaš, B., Pavlović, N. (2024). Modeling Tax Revenue Determinants: The Case of Visegrad Group Countries. *Economies, 12(6),* 131.
7. European Union, data.europa.eu, 30.11.2024.
8. Eurostat, https://ec.europa.eu/eurostat/databrowser/product/view/une_rt_a, 30.11.2024.
9. Genstwa, N. (2022). *Rozwój Gospodarczy Regionów Polski a Zmiany Emisji Gazów Cieplarnianych (Badanie w Kontekście Środowiskowej Krzywej Kuznetsa).* Uniwersytet Przyrodniczy w Poznaniu.
10. Grzelak, A., Matuszczak, A. (2011). Na drodze do ekonomii zrównoważonego rozwoju. *Kwartalnik nauk o przedsiębiorstwie, 20(3),* 48-49.
11. Héjj, D. (2023). Grupa Wyszehradzka w Unii Europejskiej. *Infos zagadnienia społeczno-gospodarcze, 9,* 1-4.
12. Hollander, S. (2005). *Jean-Baptiste Say and the classical canon in economics*. Taylor & Francis.
13. Jasiecki, K. (2020). The role and importance of economic cooperation of the Visegrad Group countries in the European Union. *Online Journal Modelling the New Europe, No. 33*, pp. 25-45. DOI: 10.24193/OJMNE.2020.33.02.
14. Jonek-Kowalska, I., Rupacz, S. (2024). Transformation of Energy Resources in the Visegrad Group: Strategies, Results, and Climate Effectiveness. *Resources*.
15. Khudoyarov, R., Kamolov, D., Azamatov, B. (2024). Economic growth, business circulation, and economic development. *Science Technology & Digital Finance, 2(2),* 21-24.
16. Knapińska, M., Siński, W. (2024). PKB uwzględniający nierówności jako miara rozwoju gospodarczego. *Nierówności Społeczne a Wzrost Gospodarczy, 77(1).*
17. Łącka, I., Suproń, B., Śmietański, R. (2024). Effects of Social and Economic Development on CO2 Emissions in the Countries of the Visegrad Group. *Energies*.

18. OECD, https://www.oecd.org/en/data/indicators/population.html, 30.11.2024.
19. Olszyk, S. (2024). Państwa Grupy Wyszehradzkiej (V4) wobec wojny w Ukrainie. Dyplomacja obronna podczas pierwszego roku wojny. *Nowa Polityka Wschodnia, 1(40),* 32-59.
20. Pastuszka (2020). Rozwój gospodarczy a jakość życia w nowych krajach członkowskich Unii Europejskiej. *Studia Prawno-Ekonomiczne, 115,* 307-327.
21. Ramzan, M., Sheng, B., Shahbaz, M., Song, J., Jiao, Z. (2019). Impact of trade openness on GDP growth: Does TFP matter? *The Journal of International Trade & Economic Development, Vol. 8,* pp. 960-995, DOI: 10.1080/09638199.2019.1616805.
22. Samuelson, P.A., Nordhaus, W.D. (2012). *Ekonomia.* Poznań: Dom Wydawniczy REBIS Sp.z o.o., p. 509.
23. Sobczak, E., Bartniczak, B., Raszkowski, A. (2021). Implementation of the no poverty sustainable development goal (SDG) in Visegrad Group (V4). *Sustainability, Vol. 13(3),* 1030.
24. Stanisz, A. (2006). *Przystępny kurs statystyki z zastosowaniem STATISTICA PL na przykładach z medycyny Statystyki podstawowe. Tom 1.* Kraków: StatSoft Polska, p. 299.
25. Stanisz, A. (2007). *Przystępny kurs statystyki z zastosowaniem STATISTICA PL na przykładach z medycyny Modele liniowe i nieliniowe. Tom 2*. Kraków: StatSoft Polska, p. 22.
26. The International Labour Organization (ILO), https://www.ilo.org/topics/wages/minimum-wages/how-define-minimum-wage, 30.11.2024.
27. Visegrad Group (2023). Available online: https://www.visegradgroup.eu, 22 December 2023.
28. Watanabe, C., Naveed, K., Tou, Y., Neittaanmäki, P. (2018). Measuring GDP in the digital economy: Increasing dependence on uncaptured GDP. *Technological Forecasting and Social Change, Vol. 137*, pp. 226-240.
29. Wojtyna, A. (2007). Teoretyczny wymiar zależności między zmianami instytucjonalnymi, polityką ekonomiczną a wzrostem gospodarczym. Gospodarka Narodowa. *The Polish Journal of Economics, 216(5-6),* 1-23.
30. Żylicz, T. (2004). *Ekonomia środowiska i zasobów naturalnych*. PWE, 13-14.