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Determinants of Unemployment in Peripheral Regions of Eastern Poland in 2008–2019

Keywords: determinants of unemployment; labour market; spatial variation

JEL: J64; J21; R11

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Abstract

Theoretical background: The origin of spatial variation in unemployment in Eastern Poland is related to the country's system transformation, with regions that relied historically on state agricultural farms and industrial plants experiencing more challenging labour market conditions. The labour market is heterogeneous, and three approaches prevail regarding the origin, occurrence, and persistence of imbalance in the labour market: structural and institutional factors, long-term adaptation processes, and wage rigidity. While economic growth is a necessary condition for reducing unemployment, a rise in the economic growth rate does not necessarily lead to increased employment until a certain GDP growth threshold is exceeded.
Purpose of the article: This study aims to conduct an empirical analysis of unemployment determinants in the Eastern region of Poland at the LAU-1 level.
Research methods: The study is based on the analysis of the equation that was adopted from unemployment rate definition. Analysis of relation between unemployment rate, growth rate of labour supply and unemployment rate in previous period, using regression models, has been calibrated using government data from five provinces of Eastern Poland, covering the period from 2008 to 2019.
Main findings: The results of the analysis show an improvement in the labour market situation during the analysed period, which is associated with the overall economic growth in Poland. The economic conditions favoured the improvement of employment indicators, corresponding to the increasing level of education in the population. The economy during the study period was characterized by stable GDP growth and decreasing unemployment rates. Similar trends were observed in the Eastern region of Poland, although the values of industrial production growth were slightly lower due to the local employment structure and regional industrial diversity. The analysis showed that a higher initial level of unemployment has a significant impact on its reduction in subsequent years. The significant impact of economic growth on reducing unemployment rates was also confirmed, especially in the category of people with lower vocational education. The study indicates the need for actions aimed at raising the level of education of people of working age, including through lifelong learning programs and active prevention of skill mismatch in the labour market. This study has limitations due to the number of analysed unemployment determinants and the limited time window of the study. Further research is necessary on the factors influencing unemployment at the regional and urban levels, taking into account the demographic structure of the population, employment quality, and gender-related aspects.

Introduction

The region of Eastern Poland contains five provinces: Warmińsko-Mazurskie, Podlaskie, Lubelskie, Podkarpackie and Świętokrzyskie. This region has special importance in research into the dynamics of unemployment and sold production of industry. In 2005, a year after Poland's accession to the European Union (EU), the region was characterized by the lowest GDP per capita in the entire EU. To stimulate economic growth in the region, an additional European fund was established for those provinces, known as Operational Programme Development of Eastern Poland. The conditions remained unfavourable in 2019: the region disclosed the lowest indicators representing sold production of industry per capita, that reached 63–64% of Poland's average (48% in the Lubelskie province).

Eastern Poland was inhabited by 21.3% of Polish working-age population (defined as men aged 18–64 and women aged 18–59); the average share of this category in the total population reached about 60.7% and was slightly greater than in Poland as a whole. The employment structure by sectors revealed overrepresentation of such sectors as agriculture, forestry, hunting and fishing, (38% of all Polish workers employed in those sectors lived in the 5 above provinces in 2019). Labour market indicators are usually studied using a comparative approach and on a national level; a crucial role may be played here by considerable variation in local structural factors.

This study is aimed to provide an empirical analysis of unemployment determinants in the Eastern Poland region on the LAU-1 level. The study is based on desk research using data published by Statistics Poland in 2008–2019. The analysed time interval represents the longest period for which information is available about the unemployment rate and sold production of industry on the LAU-1 level (county level). All data has been collected from the local statistical institution (*Główny Urząd Statystyczny*, GUS). Due to the absence of gross GDP data on the county level, the analysis uses the indicator representing sold production of industry, being the optimum substitute for GDP for research purposes. The analysed values are expressed at fixed prices of 2019 (converted using annual inflation rates published by Statistics Poland) per capita. The analytical data on unemployment represent both total unemployment rates among people at a specific education level and percentage proportions of people at a specific education level among the unemployed.

The study demonstrates which of the defined determinants affect the unemployment rate in Eastern Poland counties, and their significance levels. The results obtained can be useful in defining growth directions and are aimed to provide regional policy makers with practical suggestions, and thus possibly contribute to increased employment rates in the surveyed provinces.

Literature review

The proposition prevailing in the literature on this topic says that spatial variation in unemployment in Poland has its origins in system transformation (Dykas et al., 2013). The regions where state agricultural farms and industrial plants historically played a significant role faced with the most difficult conditions in the labour market while the regions with advanced economic structure enjoyed the most favourable conditions on that market (Kwiatkowski & Tokarski, 2007). In addition, Pośpiech (2015) indicates that similarities occur in unemployment levels in adjacent counties, forming a kind of clusters. An exception to this rule is provided by counties resistant to the effect of cluster, such as an urban county (city-county) bordering on predominantly rural counties (Dykas & Misiak, 2014). It is also observed that evolution of the labour market is determined by local initial conditions, namely significant falls

in the unemployment rate are disclosed in areas previously characterized by the greatest unemployment levels (Dykas et al., 2013).

Current economic theories indicate that the labour market lacks homogeneity (Markowicz, 2015). In the literature on this topic, three approaches prevail regarding the origin, occurrence and persistence of imbalance in the labour market (Knapińska, 2009). The first approach postulates that structural and institutional factors are responsible for that imbalance. The proponents of the second approach argue that imbalance in the labour market is caused by the long-term character of adaptation processes. The last approach considers wage rigidity as a determinant of that imbalance (Kryńska, 2000).

The set of identified principal determinants of variation in the labour market also includes such indicators as: the economic growth rate (Ciżkowicz & Rzońca, 2003), regional variation in wages (Egger et al., 2005), labour productivity (Polek-Duraj, 2013), innovation development (Węgrzyn, 2013), education level (Murawska, 2017) and capital input (Kosała, 2005).

Economic growth is a necessary condition for an effective reduction in unemployment (Czyżewski, 2002). The principal growth stimulants include: consumer demand, investment, supply and the efficiency of production factors (Samuelson & Nordhaus, 2013). The existing studies demonstrate that economic growth results in an increase in the number of active workers, provided that a rise in the economic growth rate does not entail any increase in employment until certain GDP growth threshold is exceeded (Czyżewski, 2002).

Differences in wages represent another variable affecting unemployment levels in the analysed areas. In the regions recognizing high unemployment rates, wages are lower compared to those paid in the regions with lower unemployment rates (Adamczyk et al., 2009). The wage level is inseparably related to another determinant of variation in unemployment: labour productivity. Labour productivity is defined as the volume of output produced per worker during a given reference period (OECD, 2016). Both the wage level and labour productivity are related to education. People with tertiary education received in Poland in the early 21st century wages greater by 50% than the national average, but as the number of workers holding qualifications at a tertiary level grew in time, also this category encountered problems in seeking a job (Jarecki, 2006). The literature on this topic indicates a positive correlation between tertiary education and labour productivity, occupational decisions made, improvements proposed and optimization (Gniadek & Rakowski, 2009). An equally significant role is assigned to knowledge and human capital (Miś, 2007).

Also, innovation and capital inputs influence the situation in the labour market. Węgrzyn (2013) distinguished innovation projects that contribute to creating new and attractive jobs, and those replacing workers and finally contributing to reduced employment. The existing studies demonstrated that an increase in investment caused a rise in the number of new businesses and a reduction in the unemployment rate (Horczak, 2012).

Considering the research problem outlined above, the following hypotheses were proposed:

H1: A higher unemployment level disclosed in prior years entails a significant reduction in unemployment in following years.

H2: Positive economic growth translates into lower unemployment on the county level.

H3: The categories with better education are characterized by a lower unemployment rate and a limited response to economic growth and to varying rates of prior unemployment.

Variation in the unemployment level and sold production of industry in Eastern Poland

An analysis of variation in unemployment level in Poland in 2008–2019

The registered unemployment rate, based on registers of unemployed people kept by county employment agencies, fell in the analysed period in almost all counties. The rate in Poland (on a national scale) dropped between 2008 and 2019 from 9.5 to 5.2%, and in the Eastern Poland provinces from about 10–16 to 7–9%. The greatest falls of this indicator took place in counties of the Warmińsko-Mazurskie province (10 of 11 counties that disclosed the greatest changes, including Pisz, Bartoszyce and Gołdap counties), where unemployment reached 20–30% in 2008. The smallest falls were recorded in those counties in which the unemployment rate did not substantially differ from the national average and remained over all analysed years at a constant, (relatively) low level (e.g. in Siemiatycze, Wysokie Mazowieckie counties or Rzeszów city county where the unemployment rate reached about 6–9% over the entire analysed period). Comparing data for Poland on a national scale, the first quintile group included 30 counties from the discussed provinces in the first analysed year, to rise to 36 in 2019. Considering the last quintile group, the number dropped from 7 to 4, leading to the conclusion that the region of Eastern Poland is characterized by slower growth in employment than the rest of the country.

As the dynamics of unemployment usually differs depending on the education level, a comparison of unemployment rates by education is also made. A drop in the unemployment rate was disclosed in all counties of Eastern Poland in the category with lower vocational education. In 2008, it ranged between 0.5% (Olsztyn, Lublin city counties) and 6% (Bartoszyce, Brzozów counties) while in 2019 – between 0.3% (Bielsko county, Olsztyn city county) and 3.6% (Brzozów, Lesko counties), with the largest falls reaching 2–3 pp recorded in those counties that were characterized by one of the highest rates (Krosno, Bartoszyce, Końskie counties).

Equivalent results are obtained by analysing the proportion of people with lower secondary (middle-school) and lower vocational education in the number of unem-

ployed. Falls were disclosed in almost all counties. In the first analysed year, the share of people with lower secondary education ranged between 18% (in Tarnobrzeg city county, Pińczów county) and 44% (Kętrzyn, Pisz counties), to range in the last year between 16 and 38% (Tarnobrzeg city county, Krosno city county and Elbląg, Siemiatycze counties, respectively). The sharpest falls in that share, reaching 8–9 pp, were observed in those counties that were characterized by the largest proportion in 2008. Regarding people with lower vocational education, their proportion ranged in 2008 between 16% (Olsztyn city county, Lublin city county) and 40% (Strzyżów, Bielsko counties), and in 2019 between 15% (again Olsztyn city county, Lublin city county) and 35% (Nowe Miasto, Lubaczów counties). Similarly, considering the counties characterized by the largest proportion of people with lower vocational and trade education in the number of unemployed – the sharpest falls, reaching 5–9 pp, were recognized in those counties that disclosed the highest value of that proportion in 2008. The falls observed were probably related to a general rise in education level, i.e. a reduction in the number of people holding the lowest qualification.

The unemployment rate in the category of people with upper secondary education in Eastern Poland counties ranged in 2008 between 0.3% (Bielsko, Opole Lubelskie counties) and 2.1% (Sejny, Opatów counties). In 2019, the rate ranged between 0.2% (Bielsko, Krosno counties) and 1.5% (Opatów, Sejny counties). The changes in this indicator between the first and the last year covered were not as big as in the category of people with lower vocational education and ranged between -0.9 and 0.4 pp. A rise was disclosed only in 8 counties (e.g. Hrubieszów, Przeworsk). Similar data were disclosed for people with tertiary education. Their unemployment rate ranged in the first year covered between 0.2% (Opole Lubelskie, Wysokie Mazowieckie counties) and 1.4% (Kielce city council, Przemyśl city council), to reach almost the same values in the last year, in the interval from 0.3 to 1.5%. However, a fall in the unemployment rate was recorded in this group in 34 counties while a rise occurred in 42 counties, and no change was observed in 29 counties. Importantly, the highest unemployment rates in the category of people with tertiary education in 2008 were disclosed principally in towns, but almost all of them recorded falls in this indicator over the analysed years.

The falls in the proportion of people with the lowest education level in the number of unemployed in the Eastern Poland counties, discussed above, must have resulted in a rise in unemployment in the categories with upper secondary and tertiary education. This is confirmed by the data. The proportion of people with upper secondary education in the number of unemployed roses in 2008–2019 in 74% of the counties, that of people with post-secondary and upper vocational education – in 58% of the counties, and that of people with tertiary education – in 100% of the counties in Eastern Poland. Importantly, the counties characterized by the highest share of people with tertiary education in the number of unemployed include city counties that perform the function of capital in their provinces, e.g. Olsztyn, Lublin, Rzeszów, Białystok or Kielce (a proportion between 18 and 29% in the first year and

between 25 and 30% in the last year covered). Together with people with post-secondary and upper vocational education, they represent half of all unemployed (an increase from about 45 to 50% over the analysed years). In most city counties, the proportion of people with lower secondary and primary education is roughly equal or less than that of people with tertiary education.

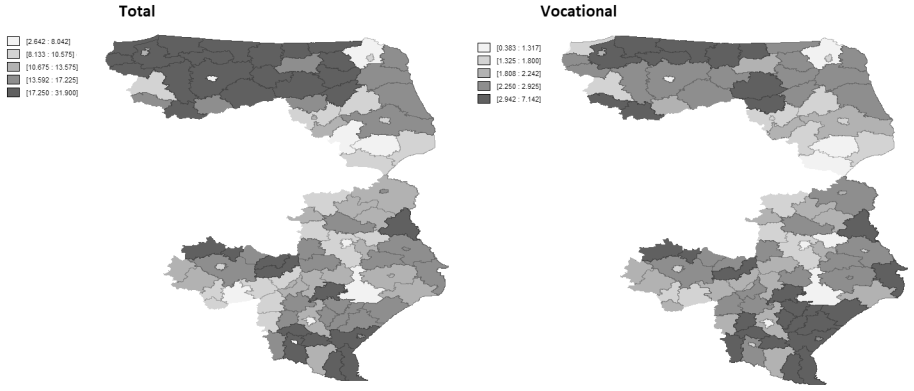
Similar changes are observed when comparing unemployment data by educational attainment on a national level. The average unemployment rate recorded in 2008–2019 both in the Eastern Poland counties and nationwide significantly dropped (almost by half compared to the first year covered) in the category of people with lower vocational education, slightly fell in the category of people with upper secondary education and was stable in the category of people with tertiary education. Detailed data are contained in Table 1.

Table 1. A comparison of average unemployment rates among people with various education levels in 2008 and 2019, in Poland generally and in Eastern Poland

Education	Average unemployment rate			
	In 2008		In 2019	
	In Poland, total	In Eastern Poland	In Poland, total	In Eastern Poland
Lower vocational	2.1%	2.6%	1.2%	1.5%
Upper secondary	0.7%	0.9%	0.5%	0.7%
Tertiary	0.5%	0.7%	0.5%	0.7%

Source: Authors' own study based on data published by Statistics Poland.

The summary of unemployment levels in the Eastern Poland counties generally and by education, depicted on the map (Figure 1), shows that the highest unemployment levels affected the northern areas. The highest unemployment rates in the category of people with lower vocational and upper secondary education were also recorded in these areas. In the counties located in southern Poland, the unemployment rate was significantly lower, but the unemployment level among people with tertiary education was distinctly higher. The data presented in Figure 1 represent the average unemployment rate in 2008–2019.



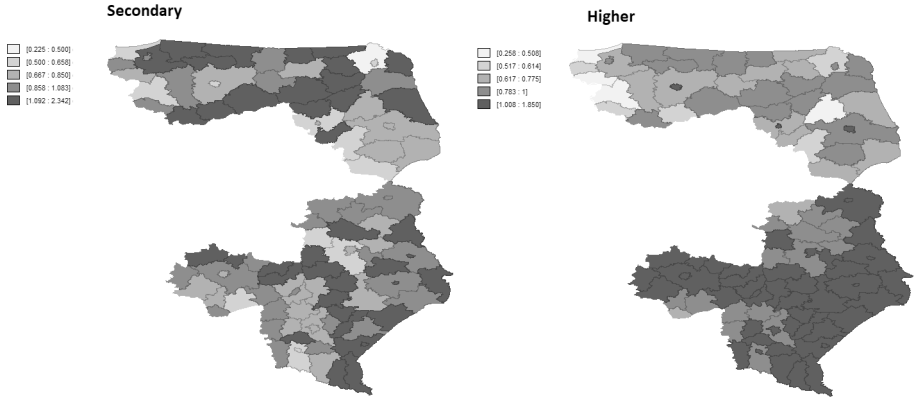


Figure 1. A comparison of average unemployment rates among people with various education levels in 2008–2019 in the Eastern Poland counties.

Source: Authors' own study based on data published by Statistics Poland.

An analysis of sold production of industry in Poland in 2008–2019

Sold production of industry is understood as the value of all products sold by enterprises, expressed at base prices (excluding VAT and excise). It also includes services provided and research and development projects completed. The value of this indicator grew in almost 90% of Polish counties over the analysed years. Regarding the Eastern Poland counties, growth was recorded in 82% of them. Although average sold production of industry was distinctly higher in all analysed years in Poland as a whole than the average calculated only for the Eastern Poland provinces (respectively, an increase from 18.5 thousand to 28.9 thousand and from 12.4 thousand to 18.7 thousand between 2008 and 2019), the growth dynamics was similar: both indicators rose over those years by 50–55%. The value of this indicator ranged in the Eastern Poland counties in 2008 from 1 thousand (Przemyśl, Sejny counties) to 65 thousand (Grajewo county). In 2019, the lower value slightly changed to 1.5 thousand (Przemyśl, Hrubieszów counties) and the upper one reached 85.5 thousand (Ostróda county). The greatest changes in nominal values were observed in those counties that began with a higher level and belonged to the 30% set of counties characterized by the highest level of sold production of industry in the first year covered. These included among others Ostróda, Starachowice, Łomża, Mielec and Bielsko counties where this value rose by 25 thousand to 49 thousand, and Opole Lubelskie, Skarżysko, Ostrowiec and Ełk counties that disclosed a fall by 5 thousand to 13 thousand. This confirms the effect of scale, observed as greater changes in this indicator in the counties characterized by a higher initial level. Comparing a percentage increase in sold production of industry over the analysed years, no similar relation was observed. The largest rises reaching 100–300% (Rzeszów, Starachowice, Bielsko, Łomża counties) were also observed in the counties characterized by one of the lowest levels of sold production of industry in 2008.

The data on sold production of industry in all Polish counties were divided into quintile groups in each of the analysed years. Table 2 contains a distribution of the Eastern Poland counties in individual quintile groups (each group always consists of 76 counties in total). The dropping number of counties included in the last quintile group (from 12 to 8), stable number of counties in the first group (37) and a slight rise in the number of counties in groups 2, 3 and 4 demonstrate that although the counties disclose rises comparable to the national average, they encounter problems in catching up the western regions due to a low initial level.

Table 2. A comparison of the numbers of Eastern Poland counties classified in specific intervals between quintiles considering the value of sold production of industry per capita

Year	Number of Eastern Poland counties classified in the interval				
	Quintile group 1	Quintile group 2	Quintile group 3	Quintile group 4	Quintile group 5
2008	37	25	17	15	12
2009	37	26	16	15	12
2010	37	22	23	13	11
2011	35	22	26	13	10
2012	36	23	21	15	11
2013	35	27	19	15	10
2014	38	23	22	13	10
2015	37	25	22	13	9
2016	38	27	21	12	8
2017	37	24	23	13	9
2018	39	23	23	13	8
2019	37	23	23	15	8

Source: Authors' own study based on data published by Statistics Poland.

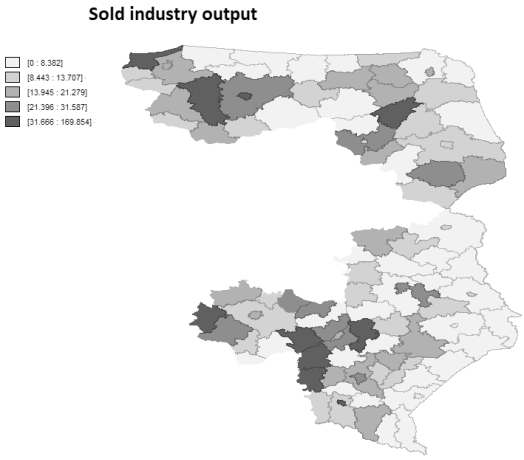


Figure 2. A comparison of average sold production of industry per capita in 2008–2019 in the Eastern Poland counties. The values are given in thousands

Source: Authors' own study based on data published by Statistics Poland.

A similar interpretation can be proposed for the data represented in Figure 2, showing average sold production of industry in 2008–2019 in the Eastern Poland counties. The towns and few counties located in the western area of the region disclosed high values of this indicator, but nationally lowest levels prevail in the largest portion of the region.

Research methods

The classical definition of the unemployment rate is adopted in a statistical analysis of its rises. This approach makes the examined increase in unemployment conditional on the value of unemployment rate in the preceding period and the growth rate of output. The following definition is adopted for this purpose (Tokarski, 2005, pp. 141–150):

$$u(t) = \frac{U(t)}{U(t)+L(t)} = 1 - \frac{U(t)}{N(t)}, \tag{1}$$

where $u(t)$ is the unemployment rate, $U(t)$ is the number of unemployed people, $L(t)$ represents the number of employed, and $N(t)$ – labour supply.

Differentiating equation (1) with respect to time t, we obtain an increase in the unemployment rate as the following derivative:

$$\frac{du(t)}{dt} = \frac{L(t)}{N(t)}\left(\frac{\frac{dN(t)}{dt}}{N(t)} - \frac{\frac{dL(t)}{dt}}{L(t)}\right),$$

It follows from the above relation and equation (1) that an increase in the unemployment rate can be translated to:

$$\frac{du(t)}{dt} = \big(1 - u(t)\big)\left(\frac{\frac{dN(t)}{dt}}{N(t)} - \frac{\frac{dL(t)}{dt}}{L(t)}\right). \tag{2}$$

Analysing equation (2), it can be concluded that the growth rate of the number of workers $\left(\frac{dL(t)/dt)}{L(t)}\right)$ is an increasing function of the production growth rate (g). Hence, there exists a map (f) such that $\frac{dL(t)/dt)}{L(t)} = f(g)$ and $\frac{df}{dg} > 0$, and an increase in the unemployment rate may be described using the following relation (Majchrowska et al., 2013, pp. 69–90):

$$\frac{du(t)}{dt} = \big(1 - u(t)\big)\left(\frac{\frac{dN(t)}{dt}}{N(t)} - f(g)\right). \tag{3}$$

An analysis of relation (3) leads to the conclusion that an increase in the unemployment rate is conditional on the growth rate of output (g), growth rate of labour supply $\left(\frac{dN(t)/dt)}{N(t)}\right)$ and on the unemployment rate $(u(t))$. Additionally, an increase in the unemployment rate is a decreasing function of the growth rate of output (g), and an increasing function of the growth rate of labour supply $\left(\frac{dN(t)/dt)}{N(t)}\right)$. If the growth rate of labour supply is greater (less) than the growth rate of the number of workers, an increase in the unemployment rate is a decreasing (increasing) function of the unemployment rate.

Results

The above theoretical discussion of rises in unemployment rates (equation (3)) is used to estimate the parameters of the following equation:[1]

$$\Delta u_{it}^{j} = \alpha_0 - \alpha_1 u_{it-1}^{j} + \alpha_2 d_{\Delta u} u_{it-1}^{j} - \alpha_3 \Delta ln(PS_{it}), \tag{4}$$

where:

u_{it}^{j} represents the registered unemployment rate in the *i*th county labour market (*i = 1, 2, 3,..., 101)* in the year *t* (*t = 2008, 2004,..., 2019*) for *j*th category of unemployed people (*j* = 0 in total; *j* = 1 lower vocational; *j* = 2 upper secondary; *j* = 3 tertiary),

$\Delta ln(PS_{it})$ growth rate of sold production of industry per capita in *i*th county in the year *t*,[2]

α_0 is a constant defining an increase in the unemployment rate that would occur at a zero-unemployment rate in the preceding period and a zero growth rate of sold production of industry,

α_1 is a variable defining the impact of unemployment rate from the preceding period, if that variable does not rise, on an increase in the unemployment rate,

α_2 measures the impact of unemployment rate from the preceding period on an increase in that variable, if the rate rises,

α_3 describes the relation between an increase in the registered unemployment rate and the growth rate of sold production of industry,

$d_{\Delta u}$ is a dummy variable that assumes the value 1 if the unemployment rate rises and otherwise is 0 (Dykas et al., 2014, pp. 57–80).

[1] In equation (4), the growth rate of labour supply is ignored, because fluctuations in labour supply in the Eastern Poland counties in 2008–2019 were relatively small compared to changes in unemployment rates.

[2] Considering the absence of GDP data on the county level, equation (4) contains sold production of industry as a macroeconomic variable that maps evolution of output in counties to a sufficient extent.

The interpretation of parameters α_1 and α_2 is determined by dichotomous variable $d_{\Delta u}$. The reason is that this variable in the equation describing an increase in the unemployment rate has the role of a switching variable that adjusts the effect of unemployment rate from the preceding period on a change in the examined unemployment rate, by taking into account its rise or fall (Dykas et al., 2013, pp. 9–21).

Calculations made as per equation (4) using the real data from the regions, lead to the following results of linear regression.

Table 3. Estimated parameters in equation 4 for total unemployment

Source	SS	df	MS	Number of observations	1,007	
Model	0.1804	3	0.0601	F(3, 1003)	534.5500	
Residual	0.1128	1.003	0.0001	Prob>F	0.0000	
Total	0.2932	1.006	0.0003	R^2	0.6152	
				$Adjusted\ R^2$	0.6141	
				Root MSE	0.0106	
Explanatory variables						
Δu_{it}^{j}	Coef.	Std.err	T	P>|t|	95% conf. interval	
$\Delta ln(PS_{it})$	-0.1141	0.0024	-4.68	0.000	-0.1620	-0.0066
$\alpha_2 d_{\Delta u} u_{it-1}^{j}$	0.0275	0.0007	38.02	0.000	0.0261	0.0289
$\alpha_1 u_{it-1}^{j}$	-0.4063	0.0056	-7.26	0.000	-0.0516	-0.2966
α_0	-0.0077	0.0009	-8.24	0.000	-0.0095	-0.0584

Source: Authors' own study based on data published by Statistics Poland.

Table 4. Estimated parameters in equation 4 for the unemployed with tertiary education

Source	SS	df	MS	Number of observations	1,007	
Model	0.0018	3	0.0006	F(3, 1003)	759.2600	
Residual	0.0080	1.003	$8.0040 \cdot 10^{-7}$	Prob>F	0.0000	
Total	0.0026	1.006	$2.6103 \cdot 10^{-6}$	R^2	0.6943	
				$Adjusted\ R^2$	0.6934	
				Root MSE	0.0009	
Explanatory variables						
Δu_{it}^{j}	Coef.	Std.err	T	P>|t|	95% conf. interval	
$\Delta ln(PS_{it})$	-0.0008	0.0002	-4.00	0.000	-0.0012	-0.0004
$\alpha_2 d_{\Delta u} u_{it-1}^{j}$	0.0027	0.00006	45.26	0.000	0.0026	0.0028
$\alpha_1 u_{it-1}^{j}$	-0.0582	0.0074	-7.82	0.000	-0.0728	-0.0436
α_0	-0.0003	0.00009	-3.42	0.001	-0.0005	-0.0001

Source: Authors' own study based on data published by Statistics Poland.

Table 5. Estimated parameters in equation 4 for the unemployed with upper secondary education

Source	SS	df	MS	Number of observations	1,007	
Model	0.0014	3	0.0005	F(3, 1003)	527.69	
Residual	0.0009	1.003	$8.8007 \cdot 10^{-7}$	Prob>F	0.0000	
Total	0.0023	1.006	$2.2623 \cdot 10^{-6}$	R^2	0.6122	
				$Adjusted\ R^2$	0.6110	
				Root MSE	0.0009	
Explanatory variables						
Δu_{it}^{j}	Coef.	Std.err	T	P>|t|	95% conf. interval	
$\Delta ln(PS_{it})$	-0.0009	0.0002	-4.44	0.0000	-0.0014	-0.0005
$\alpha_2 d_{\Delta u} u_{it-1}^{j}$	0.0026	0.00007	37.83	0.0000	0.0025	0.0027
$\alpha_1 u_{it-1}^{j}$	-0.0730	0.0079	-9.26	0.0000	-0.0885	-0.0576
α_0	-0.0001	0.0009	-1.23	0.220	-0.0003	-0.0001

Source: Authors' own study based on data published by Statistics Poland.

Table 6. Estimated parameters in equation 4 for the unemployed with lower vocational education

Source	SS	df	MS	Number of observations	1,007	
Model	0.0065	3	0.0022	F(3, 1003)	464.92	
Residual	0.0047	1.003	$4.6768 \cdot 10^{-6}$	Prob>F	0.0000	
Total	0.0112	1.006	$1.1 \cdot 10^{-5}$	R^2	0.5817	
				$Adjusted\ R^2$	0.5804	
				Root MSE	0.0216	
Explanatory variables						
Δu_{it}^{j}	Coef.	Std.err	T	P>|t|	95% conf. interval	
$\Delta ln(PS_{it})$	-0.0021	0.0005	-4.23	0.0000	-0.0031	-0.0011
$\alpha_2 d_{\Delta u} u_{it-1}^{j}$	0.0055	0.0001	35.59	0.0000	0.0052	0.0058
$\alpha_1 u_{it-1}^{j}$	-0.0441	0.0059	-7.51	0.0000	-0.0556	-0.0325
α_0	-0.0013	0.0002	-7.38	0.0000	-0.0016	-0.0009

Source: Authors' own study based on data published by Statistics Poland.

The results obtained in the above tables demonstrate that the examined increase in the unemployment rate, considering its division into three education level cases plus the general case, that are described by the above equations, is suitable for providing an explanation of the real values in this area to a degree that is at least satisfactory, as confirmed by the values of R^2. The tested parameters are statistically significant in all cases, allowing to draw conclusions as to the current value of unemployment rate that is described by the above variables contained in the proposed equations.

The model's input data demonstrate that an increase in sold production of industry in the current period has a favourable effect on the unemployment rate, leading to a reduction in its value in all cases. However, differences between the four cases are

evident, with the effect being significantly stronger in the general category. Its value was higher compared to the specific cases defined by education, and relative to the extreme case of tertiary education, it had an effect reducing the unemployment rate that was stronger by 14 times at growing output. This means that the category of people with tertiary education is characterized by a considerably lower sensitivity to an increase in sold production of industry compared to a fall in the unemployment rate. The examined unemployment rate is much more sensitive in the case of lower vocational education that shows strong procyclical characteristics relative to sold production of industry, being by about 5.5 times less sensitive to an increase in output than the general category. However, this sensitivity measure remains considerably greater than in the above case of tertiary education. This relation is demonstrated by comparing the sensitivity of the unemployment rate to an increase in sold production of industry between education categories. The conclusion can be drawn that people with lower vocational education will be hired in a much greater proportion than people with tertiary and upper secondary education; with this proportion being greater than double when the output grows. Considering the variables that define the impact of unemployment rate from the preceding period, both when this rate does not rise and when it rises, their effect on the general unemployment rate, in addition to natural desirable or adverse consequences, is characterized by asymmetry. The impact difference in the general case was almost 1.5 times greater when the unemployment rate did not rise in the preceding period. Similar observations are made in special cases, i.e. in specific education categories, provided that the desirable impact reducing the unemployment rate was characterized by much greater disproportions, compared to the instance with an increasing unemployment rate, than in the general case. The most striking difference reaching 27 times was observed in the case of upper secondary education. This is also the case in which this variable had the greatest reducing effect on the unemployment rate compared to other education categories and to all other variables, and this must be strongly emphasized. The smallest disproportion was observed in the case of lower vocational education, with the impact being almost eight times stronger when the unemployment rate did not rise in the preceding period. The conclusion is clear that under adverse market conditions associated with increasing unemployment in the preceding period, the problem of unemployment in the examined period affects to the greatest extent people with lower vocational education while people with upper secondary and tertiary education are affected by this problem to a more than twice smaller degree compared to people with lower vocational education. Under opposite conditions, with the unemployment rate that did not rise in the preceding period, people with upper secondary education will be hired in a greatest proportion, being 1.5 times greater than in the category of lower vocational education and by twenty percent greater than in the category of tertiary education.

The values described above therefore provide a solid basis for confirming the hypotheses: H1 – regarding the relationship between the higher level of unemployment recorded in previous years and a significant reduction in unemployment in the

following years, H2 – about the positive impact of economic growth on the decline in the unemployment rate, and hypothesis H3 – indicating the impact of education on the unemployment rate and limited by the reaction of this rate to economic growth and changes in the unemployment rate in earlier periods. Economic growth was indicated as necessary condition for effective reduction in unemployment by many authors before (Czyżewski, 2002; Samuelson & Nordhaus, 2013). Presented research confirms existing studies that demonstrate economic growth results in an increase in the number of active workers. Positive correlation between tertiary education and labour productivity indicated by Gniadek and Rakowski (2019) is in line with obtained result about connection between education and unemployment rate.

Conclusions

The economic conditions prevailing in Poland in the analysed period of 2008–2019 stimulated an improvement in employment indicators, corresponding to a rising education level in the population (resulting both from a better education level among people entering the labour market and from retirement of older cohorts with a lower level of education). The economy was characterized by stable GDP growth and falling unemployment rates. The data describing Eastern Poland reveal the same trends as observations made in the remaining territory of Poland, with slightly lower growth values of sold production of industry, due to a lower initial value and the local sectoral structure of employment, especially in the areas with prevailing government sector, and to regional diversification of industry.

The obtained study results confirm the proposed hypotheses. An initial higher unemployment level has a significant effect on a considerable reduction in unemployment rates in following years. In line with the assumptions adopted, the significant effect of economic growth on a reduction in unemployment rates was also confirmed, especially in the category of people with lower vocational education. This category also occurred to be more sensitive to general labour market conditions, as demonstrated by both statistical modelling results and descriptive statistics analysis.

Practical implications of the study include the need of taking measures aimed to rise the education level of working-age people, such as lifelong learning programmes and active prevention of skills mismatch in the labour market. Unemployment leads to incomplete utilization of human capital, deeper social inequality, a dramatic reduction in potential domestic product and national income; and therefore, determinants and factors of unemployment must be studied as precisely as possible on all levels of territorial division.

The study is limited due to the number of analysed unemployment determinants and the time series explored. Research must be continued into the factors affecting unemployment on the regional and township level, including the demographic structure of population, employment quality and gender aspects, in addition to those

discussed above. A particularly interesting research path would be to extend the research results to include the last of the components mentioned, namely gender, because existing empirical research in this area indicates that the issue of reducing unemployment moderated by sold industrial production was strongly discriminates factor for women in Eastern Poland (Bolińska et al., 2023). It would also be beneficial for the study to divide the education cohorts into specific educational paths, where particular attention would be paid to education in the engineering & technology area with has special impact for decrees unemployment rate (Żyra, 2022).

Another limitation of the study can be seen in using the percentage of people registered in employment agencies as an indicator of unemployment. An objective of continued research is to verify how precisely this indicator reflects the number of unemployed people obtained from representative surveys, because official unemployment may be underestimated due to the sceptical attitude displayed by a group of citizens towards registration with employment agencies.

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