

THE IMPACT OF TECHNOLOGICAL CAPACITY DEVELOPMENT ON THE LABOR MARKET CONDITION. THE CASE OF THE DOLNOŚLĄSKIE AND LUBUSKIE VOIVODSHIPS

WPŁYW ROZWOJU ZASOBÓW TECHNOLOGICZNYCH NA SYTUACJĘ NA RYNKU PRACY. PRZYKŁAD WOJEWÓDZTWA DOLNOŚLĄSKIEGO I LUBUSKIEGO

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Abstract: The aim of the article is to assess the impact of the development of technological capacity on the labour market in Poland, in voivodships with significantly different GDP levels: the Dolnośląskie and nearly four times smaller the Lubuskie. Data for the years 2002-2017 were obtained from the CSO Local Data Bank. The research used linear regression analysis and the OLS estimation method. The results have shown that the expenditure on R&D are not a positive factor of employment growth in both voivodships, which may be due to their low values in relation to GDP (on average around 0.5%). The number of students and universities had a positive impact on the labour market in both regions. The catch-up effect and accelerated development recorded in the second part of the examined period in the Lubuskie could have had an impact on better absorption of university graduates and registered patents by businesses and their positive impact on employment levels, in contrast to the Dolnośląskie. Improvement in the economic situation in both voivodships and in the whole country also had a positive impact on the improvement of conditions on the labour market.

Keywords: labour market, technological development, education, regional development

Streszczenie: Celem artykułu jest ocena wpływu rozwoju zasobów technologicznych na sytuację na rynku pracy w Polsce w województwach o znacznie zróżnicowanej wielkości PKB: dolnośląskim i blisko czterokrotnie mniejszym, lubuskim. Dane za lata 2002-2017 pozyskano z Banku Danych Lokalnych GUS. W badaniach zastosowano analizę regresji liniowej i estymacji metodą najmniejszych kwadratów (MNK). Wyniki badań wykazały, że ponoszone nakłady na R&D nie stanowią pozytywnego czynnika wzrostu zatrudnienia w obu województwach, co może wynikać z ich niskich wartości w relacji do PKB (średnio około 0,5%). Pozytywnie na rynek pracy w obu regionach wpływała liczba studentów i uniwersytetów. Efekt dochodzenia i przyspieszonego rozwoju notowany w drugiej części badanego okresu w województwie lubuskim mógł mieć wpływ na lepszą absorpcję absolwentów uniwersytetów i zarejestrowanych patentów i ich pozytywny, w przeciwieństwie do dolnośląskiego, wpływ na poziom zatrudnienia. Na poprawę rynku pracy pozytywny wpływ miała również poprawa sytuacji gospodarczej w obu województwach a także w całym kraju.

Słowa kluczowe: rynek pracy, postęp technologiczny, edukacja, rozwój regionalny

Introduction

Employment may become the main socio-economic problem of the 21st century (Peukert, 2012). The solution to this problem is important not only for individual Member States, but also for the entire European Union. An efficiently functioning labour market may in the future decide on the level at which a common economic area will operate (Habermas, 2012). Although obtaining full

employment seems to be a distant prospect, nevertheless governments of individual countries activate promotional programmes aimed at full professional activation of society and maximum utilization of its human capital. Pierenkemper (2012) believes, however, that it will probably be difficult to achieve full employment in the European Union by the mid-21st century, even taking into account many programmes run by governments to increase employment and reduce unemployment.

The progressing process of globalization of the economy and society, as well as technological development and automation means that the demand for human labour is constantly decreasing. Economic growth often no longer requires increasing employment (Kośmicki, Malinowska, 2016). Currently, the level of technological development and competence of the human labour potential is becoming important for the labour market (Batorski, Błażewicz, 2015). The literature on the subject differently assesses the impact of technological progress on the labour market. Already, since the second half of the 20th century, there has been some anxiety in society related to the reduction of employment levels by technological advances. Albus (1976), Noble (1993), Rifkin (1995) and McAfee and Brynjolfsson (2011) note that automation and technological potential shift demand for work towards engineering professions, and additionally introduce differentiation in income levels.

In turn, Kornowski (2016) states that technological innovations are needed and have an impact on changes in the structure of expenditure and thus on the level of income. The most important economic effect of unemployment, and at the same time one of the largest social costs resulting from this phenomenon, is a decline in the gross domestic product (GDP). The size of this type of loss is measured by the GDP gap, defined as the difference between the potential GDP generated in conditions of full employment (when only voluntary unemployment exists) and the actual amount of real GDP that will be achieved at a given point in time (Unolt, 1996).

In contrast, Rumberger and Levin (1985), researching the labour market and the level of unemployment in the United States, observe that technological development does not contribute to the creation of new jobs, as assumed by advocates of digitalization of the economy. They assume that in the coming decades the economy would need a cheaper and less qualified workforce, especially in the area of services. The lack of a uniform opinion on the impact of the technical development on the labour market has become a motivation to examine the impact of factors related to technological development on the state of the labour market.

The aim, materials and research methods

The aim of the article is to assess the impact of the development of technological capacity on the labour market in Dolnośląskie and Lubuskie voivodships. The results of this study fill the gap in the literature in this area. Statistical data used in the research come from databases and publications of Statistics Poland (GUS), including the Local Data Bank and

Statistical Yearbook of Dolnośląskie and Lubuskie Voivodships. The research used linear regression analysis and the OLS estimation method. The research results were presented using tabular methods. The analysed voivodships were selected on the basis of the GDP per capita measure. The Dolnośląskie is in second place in Poland in terms of the size of this indicator. In turn, the Lubuskie is in this category a median among voivodships in Poland.

Labour market and technological development – literature review

Human capital as a factor of production is of great importance to the economy. This is demonstrated by the consequences that may arise as a result of not using part of the workforce. The consequences of this can be both negative and positive. It all depends on the duration of the excessive unemployment period and whether it is considered from the point of view of public authorities, employer or employee (Sztanderska, 1993).

Szylo-Skoczny (2001) distinguishes the following effects of unemployment:

1. Individual – including: poverty, deterioration of living standards, a feeling of lowering social status, too much free time to manage, occurrence of depressive symptoms (discouragement, sadness, indifference, depression), cognitive disorder (processing of impressions and reception);
2. Family – among others: atmosphere of tension, decrease in school achievements of children, reduction of living standards, disintegration, resignation from cultural life, plans and dreams;
3. Social consequences of mass unemployment – are of both a social and family-related character including: increasing pension contribution, insurance premiums and taxes, reducing the fulfilment of needs, occurrence of frustration manifested especially in antisocial behaviour, alcoholism, destruction of family ties, aggression, divorce, demoralization of less mentally resistant individuals, development of crime.

The above-mentioned effects of unemployment can only be classified as negative, however, there are also positive sides of unemployment. The threat of long-term unemployment can help maintain order and discipline in enterprises and significantly reduce employees' wage demands. These effects are important, both from a macro- and microeconomic perspective. The macroeconomic approach considers unemployment as a deflationary factor. On

the microeconomic side, unemployment reduces the cost of operations and improves its profitability (Kaczmarczyk, 2016).

In the modern world, technological unemployment is noticeable. It results from automation and technological progress in production and replacement of the labour force by machines. This phenomenon was first observed by Keynes, who noticed that changes in manufacturing processes create a decrease in jobs, not an increase. This is evident at a time of low economic growth, when investments are focused on modernization of production processes and an increase in sales while reducing employment (Bitner et al., 2014).

Since the second half of the 20th century technological progress has become an important determinant of economic growth. It is also an inseparable element of the development of society. In economic literature, technical development is understood as all kinds of changes in work organization as well as in manufacturing techniques which have an impact on increasing the efficiency of business operations (Mazur 2000).

The assessment of the impact of education and expenditure on research and development (R&D) on employment is varied. On the one hand, it is assumed that the increase in the number of students and university graduates creates the potential for increasing work efficiency and economic development of the region. However, it is also noted that excessive focus on general education, while neglecting the training of practical and professional skills, does not improve the quality of the labour market and accelerate a regional development pace.

Zhou et al. (2020) based on the Hong Kong labour market in 1991-2011 indicate the existence of a positive impact of education on the level of labour market conditions and economic development. They noticed that employees who know two languages, i.e. English and Mandarin, performed more advanced professional work and received higher salaries than employees with similar education, but speaking only one native language. Additionally, Chinoracky and Corejova (2019) state that digital technologies generate new opportunities for creating new products enhance the competitiveness of enterprises. Positive results of technical education for development of the regional and national economy are expected in particular by countries with a lower level of development. Their research in Kazakhstan's largest industrial centres has shown that the intellectual potential and expenditure on R&D are the strongest stimulus for increasing the competitiveness of enterprises operating in these centres.

On the other hand, research conducted in the United States in the 1980s shows that technological development does not always create new jobs. For the proper development of the economy it is necessary to ensure a sufficient number of employees with lower professional qualifications, including those with lower remuneration and specializing in providing consumer services (Rumberger, Levin, 1985). Also, research on the labour market in Switzerland and Bulgaria conducted by Heiniger and Imdorf (2018) shows that the relationship between the level and the size of education and employment is much weaker in countries with less vocational education and a greater share of general education. In contrast, the labour market research in Australia conducted by Marx (2018) shows that graduates do not always have a better start on the labour market. Only graduates with the best university grades can have good job prospects, while the prospects of obtaining highly paid jobs by graduates with lower grades are much weaker. Often, it turns out that for this group of graduates to build their professional careers, graduating from vocational schools is a much better solution.

The macroeconomic situation of the Dolnośląskie and Lubuskie voivodships

The Dolnośląskie belongs to the group of the largest voivodships in Poland, both in terms of the number of inhabitants and the value of generated GDP (Figure 1). Its GDP grew the most quickly after Poland's accession to the EU. This accelerated development allowed the Dolnośląskie significantly and permanently overtake the national average in terms of GDP per capita. The crisis in public finances in the Euro area has contributed to a slower economic growth after 2010.

The Lubuskie belongs to the group of smaller voivodships both in terms of population and GDP. Accession to the EU did not contribute to a noticeable improvement in the economic situation until 2013. However, for both voivodships, Poland's accession to the EU helped in improvement of the labour market situation (Figure 2). The global financial crisis noticed in Poland since 2008, followed by the crisis of public finances in the Euro area countries significantly increased the level of unemployment and reduced employment. A significant improvement in these parameters, especially in the Dolnośląskie, is observed after 2014, inter alia due to the supporting governmental programmes and a better economic situation of the Western European countries, the main foreign recipients of Polish goods and services.

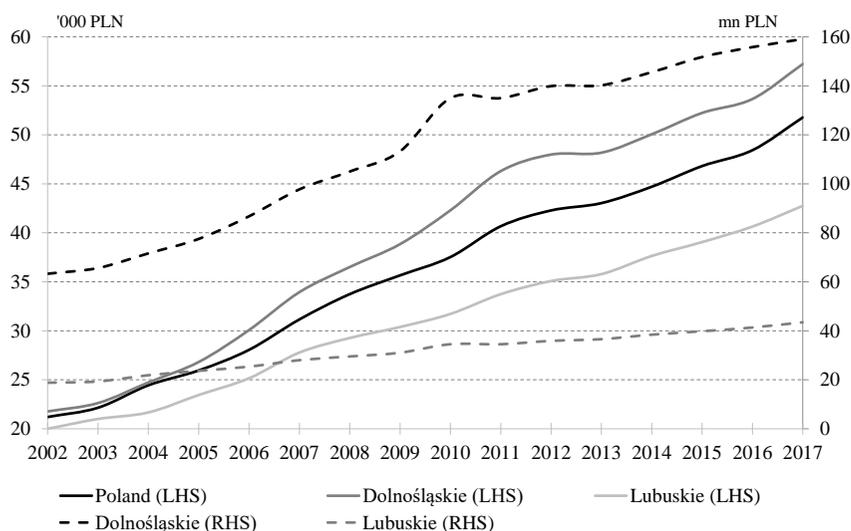


Figure 1. GDP (RHS) and GDP per capita (LHS) in 2002-2017
Source: Statistics Poland (Local Data Bank).

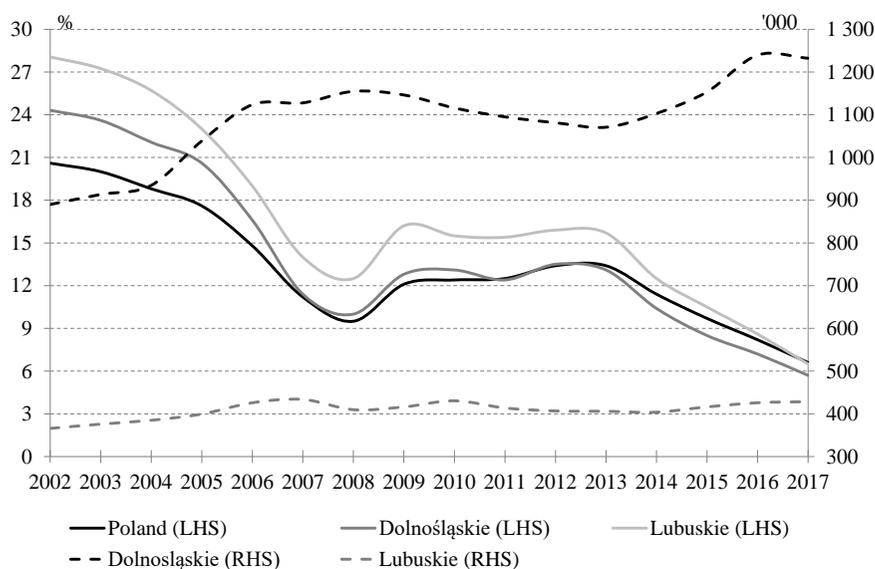


Figure 2. The level of employment (RHS) and the unemployment rate (LHS) in 2002-2017
Source: Statistics Poland (Local Data Bank).

Data and research methods

The CSO Local Data Bank was the primary source of data for the research. The quarterly data covering the period of 2002-2017 were applied to the regression assessing the impact of technological development on the labour market situation. Technological development is represented by the following variables: expenditure on R&D (R&D), the number of registered patents (PAT), the number of students (STU), the number of university graduates (GRA) and the number of universities (UNI). For the sake of comparability between these values in

individual voivodships and in Poland they were referred to the number of inhabitants of a given entity. The labour market in a given voivodship is represented by the number of employees (EMP) and the number of employees related to the number of inhabitants (EMP.pc) and the unemployment rate (UNE.rate). To control the impact of the macroeconomic situation on the labour market, an additional regressor was introduced, which is GDP per capita (GDP.pc). Table 1 presents the numerical characteristics of the variables used in the study, and Table 2 shows the degree of correlation between them.

Table 1. Descriptive statistics for variables used in the research

Variable	Number of observations	Mean	Standard Deviation	Minimum	Maximum
UNE.rate	192	1.1E+01	6.2E+00	2.5E+00	2.8E+01
EMP	192	5.6E+03	6.9E+03	3.7E+02	1.7E+04
EMP.pc	192	4.0E-04	2.8E-05	3.1E-04	4.4E-04
POP	192	1.4E+07	1.7E+07	1.0E+06	3.9E+07
GDP.pc	192	3.7E+04	1.0E+04	1.9E+04	5.7E+04
R&D	192	4.2E+03	6.2E+03	2.3E+01	2.1E+04
R&D.pc	192	2.1E+02	1.6E+02	2.3E+01	5.4E+02
PAT	192	1.2E+03	1.6E+03	1.4E+01	4.7E+03
PAT.pc	192	8.1E-05	3.8E-05	1.4E-05	1.6E-04
STU	192	6.2E+05	7.7E+05	1.3E+04	2.0E+06
STU.pc	192	4.1E-02	1.4E-02	1.3E-02	6.0E-02
GRA	192	1.5E+05	1.9E+05	3.2E+03	4.9E+05
GRA.pc	192	9.9E-03	2.8E-03	3.1E-03	1.5E-02
UNI	192	1.6E+02	1.9E+02	6.0E+00	4.5E+02
UNI.pc	192	1.0E-05	2.2E-06	5.9E-06	1.3E-05

Note: UNE.pc – unemployment rate, EMP – number of employees, POP – population number, GDP gross domestic product, R&D – funds for research and development, PAT – number of patents, STU – number of students, ALM – number of graduates, UNI – number of universities, pc – variable over one person.

Source: the author's own study based on Statistics Poland (Local Data Bank) data.

Table 2. Correlation ratios for variables used in the research

Variable	EMP	EMP.pc	UNE.rate	GDP.pc	R&D.pc	PAT.pc	STU.pc	GRA.pc	UNI.pc
EMP	1.00								
EMP.pc	0.161**	1.00							
UNE.rate	-0.120*	-0.801***	1.00						
GDP.pc	0.101	0.509***	-0.768***	1.00					
R&D.pc	0.478***	0.326***	-0.499***	0.590***	1.00				
PAT.pc	0.161**	-0.003	-0.334***	0.570***	0.605***	1.00			
STU.pc	0.170**	-0.541***	0.465***	-0.143**	0.152**	0.359***	1.00		
GRA.pc	0.247***	-0.281***	0.171**	0.229***	0.462***	0.580***	0.569***	1.00	
UNI.pc	0.342***	-0.242***	0.031	0.304***	0.523***	0.541***	0.551***	0.532***	1.00

Note: ***, **, * - significant level of 1%, 5%, 10%.

Source: the author's own study based on Statistics Poland (Local Data Bank) data.

Data referring to both analysed voivodships and, for comparative purposes, to Poland were regressed. Two models were used to assess the impact of technological development on the level of employment. In the first of them the labour market is represented by the number of employees (EMP), and in the second one by the number of employees in relation to the number of inhabitants of a given

entity (EMP.pc). The estimates were carried out using the STATA statistical programme. The results of the estimation are presented in Table 3.

To confirm the correctness of the results obtained, a third model with the labour market represented by the unemployment rate was estimated, while maintaining the same descriptive variables (Table 4).

Table 3. The impact of technical development on the employment level - regression results

Variable	EMP			EMP.pc		
	PL	DO	LU	PL	DO	LU
GDP.pc	6.9E-09***	7.8E-09***	1.4E-08***	2.6E-01***	2.2E-02***	1.3E-02***
R&D.pc	-1.5E-07***	-1.3E-07***	-9.4E-08*	-5.5E+00***	-3.7E-01***	-8.6E-02
PAT.pc	7.6E-02	-5.9E-01***	1.5E-01***	3.0E+06	-1.7E+06***	1.6E+05**
STU.pc	3.4E-03***	4.7E-03***	5.4E-03***	1.2E+05***	1.3E+04***	4.4E+03***
GRA.pc	-1.2E-02***	-2.1E-02***	2.2E-02***	-4.1E+05***	-5.5E+04***	2.4E+04***
UNI.pc	1.5E+01***	9.2E+00***	-4.9E+00**	4.9E+08***	2.4E+07***	-5.0E+06**
CONS	-5.3E-06	4.8E-05**	-2.9E-04***	5.2E+02	1.7E+02***	-2.4E+02***
NO of OBS	64	64	64	64	64	64
F – STAT	656.53	399.03	58.22	843.53	499.03	64.46
PROB>F	0	0	0	0	0	0
R2	0.986	0.977	0.8597	0.9757	0.9783	0.8716

Note: ***, **, * - significant level of 1%, 5%, 10%, PL – Poland, DO – Dolnośląskie, LU – Lubuskie.

Source: the author's own study based on Statistics Poland (Local Data Bank) data.

Table 4. The impact of technical development on the unemployment rate - regression results

Variable	UMP.rate		
	PL	DO	LU
GDP.pc	-1.8E-03***	-1.3E-03***	-3.1E-03***
R&D.pc	4.6E-02***	2.0E-02***	4.5E-02**
PAT.pc	-7.1E+03	-1.5E+04	-2.4E+04
STU.pc	-8.9E+02***	-8.6E+02***	-9.7E+02***
GRA.pc	2.7E+03***	2.7E+03***	-2.7E+03***
UNI.pc	-1.7E+06***	9.8E+04	-1.1E+06*
CONS	9.3E+01***	7.2E+01***	1.6E+02***
NO of OBS	64	64	64
F – STAT	455.02	428.06	127.46
PROB>F	0	0	0
R2	0.9795	0.9783	0.9256

Note: ***, **, * - significant level of 1%, 5%, 10%, PL – Poland, DO – Dolnośląskie, LU – Lubuskie.

Source: the author's own study based on Statistics Poland (Local Data Bank) data.

The research results indicate that, at the current level of technological and economic development of Poland, for both analysed voivodships the expenditure on R&D does not have a positive impact on the employment level or the unemployment rate. The negative sign of the indicators for the variable R&D may result from the fact that in Poland the level of technological advancement of the workplaces is not high and relatively low expenditures on R&D do not have a direct impact on the condition and characteristics of the economy. According to the data of the Central Statistical Office, in relation to GDP, expenditure on R&D in 2016 amounted to 0.69% and 0.20%, respectively in the Dolnośląskie and Lubuskie

voivodships. Regression results also do not indicate a clear direction of the impact of the number of registered patents per capita. In the Dolnośląskie there is no positive impact of this variable on the size of employment, in contrast to the Lubuskie, where the positive impact of this factor on the labour market situation is noted.

In turn, the number of students per capita clearly has a positive impact on the labour market. In both voivodships the increasing number of students contributed to the increase in employment, with the strongest impact of this factor being noticed in the Lubuskie. The simulative nature of this factor for the quality of the labour market also confirms the

negative impact of the increase in the number of students on the unemployment rate (Table 4).

Research results for the Dolnośląskie also indicate a positive impact of the number of universities on the labour market condition. This may be due to the fact that universities are centres of specialist knowledge and also that train experts working in the local economy or supporting it with their advice. Additionally, a lack of a positive impact of the number of university graduates per capita on the employment volume in the Dolnośląskie may result from an inadequate educational structure at universities.

A similar relationship was indicated by, among others, Heiniger and Imdorf (2018). Researching the labour markets in Switzerland and Bulgaria they state that the relationship between employment and the level and scale of education is much weaker in countries with a smaller share of vocational education and a greater share of general education. In addition, the Ministry of Science and Higher Education in Poland (MNiSzW) in the justification of the Constitution for Science Act adopted in 2018 (MNiSzW, 2018) states, that in Poland there is a problem of inadequacy of the structure of the higher education system and the need to strengthen vocational universities which are focused on high-quality didactics conducted as part of practical studies. This situation may explain the fact that an increase in the number of university graduates does not improve the labour market at all, i.e. it does not increase employment and does not reduce the level of unemployment. However, there is an opposite situation in the Lubuskie, where the increasing number of graduates is improving the situation on the labour market defined by both the size of the employment and unemployment rate. Such correlation may result from the fact that the Lubuskie having almost a four times lower GDP than the Dolnośląskie, especially during the recent period, has accelerated the pace of its development. Since 2012, the GDP growth rate of this voivodship has been higher than that of the Dolnośląskie, this creates conditions for much stronger absorption of university graduates by business entities.

Positive signs of the GDP.pc indicators signify that the improvement of the macroeconomic conditions of voivodships and the entire country contributes to an increase in employment as well as to a reduction of the unemployment rate. This factor has a much stronger impact in the faster developing voivodship - Lubuskie than in the Dolnośląskie.

Conclusions

The development of technological resources in the economy ambiguously affects the situation on the labour market in the Dolnośląskie and Lubuskie voivodships.

Expenditure on R&D in both voivodships did not produce positive effects on the size of the employment or unemployment rate. This most probably results from the fact that these outlays are not of high value and cannot have a noticeable impact on the general economic situation in both voivodships.

The number of registered patents has no statistically significant effect on the level of the unemployment rate and has an ambiguous effect on the level of employment. In the case of the Dolnośląskie, the sign of the regression coefficient is negative, and for Lubuskie is positive, which may result from a significant differentiation in the size of the economy of both voivodships.

The numbers of students studying as well as the number of universities have a positive impact on the quality of the labour market. Such an impact can be explained by the fact that universities are centres of expert knowledge, as well as the initiators of innovative projects contributing to the general economic development and to an increase in the turnover of enterprises, which in effect is a source of demand for employees.

The effect of catching-up perceived in the economy of the Lubuskie is also a probable reason for the higher absorption of university graduates than in the Dolnośląskie. The negative relationship between the change in the number of graduates and the level of employment in the Dolnośląskie most probably results from an inadequate educational structure of universities and insufficient focus on technical faculties, which is also indicated by research conducted in other countries.

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