Analysis of the effectiveness of vocational education in terms of labour market demand in Poland

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Abstract: Vocational education is an important topic in the context of human capital. This is due to the mere fact of the Copenhagen process, which for over 15 years has been aiming to improve the quality of education in the European Union. Nevertheless, the state of vocational education in this area is far from expected. In this case, the Polish vocational education system is one of the most negative examples [Polcyn, Gawrysiak 2017, p. 13], both in the context of the level of unemployment, as well as the clarity and coherence of the system itself. The authors have attempted to explore the reasons for this condition in the context of the effectiveness of vocational education in terms of labour market demand, based on the data from 2016 at NTS-4 level. The analysis used the new database of the Occupation Barometer, data prepared by the Polish Central Statistical Office on the number of students trained according to the ISCED-F 2013 international classification, and social and economic measures were taken into account. The results of linear models indicate the lack of a direct relationship between education in five most numerous ISCED-F 2013 narrow fields in Poland and demand on the labour market, according to the data from Occupation Barometer. The authors additionally propose a new measure of effectiveness, based on the collected data, and present an example of its use in the logistic regression method. The results show possible issues resulting from vocational schools management and vocational education "inertia".

Keywords: economy, education, vocational education, VET, effectiveness

JEL: I25, I26, I28

Introduction

The Polish vocational education system is one of the most complex and diverse in the European Union [Onisep 2017]. Unfortunately, it has many negative features which, despite the Copenhagen process being implemented in Poland, still show symptoms of its inertia. This phenomenon occurs in many systems and results in further failure of the process itself in the European Union, where it is still difficult to find very similar systems, but at the same time there is a very large variation between them. In the article by Polcyn & Gawrysiak (2017), in which the discussion on the effectiveness of vocational education systems was presented, the authors analysed data from 2010 to 2015. There were significant differences between vocational education systems, and it was pointed out that Poland has many negative features.

With the large participation of vocational education in secondary education, Poland, together with Romania, is second in terms of the scale of unemployment among people with vocational education at secondary level. Although the share of vocational training after secondary school (post-secondary, non-tertiary education) is 28% in relation to the entire vocational training, Poland is characterised by higher unemployment than, for example, Lithuania or Estonia, which with a share of 40% have an unemployment rate of 3.5%. Most systems of vocational education in the European Union were characterised by coherence and simplicity, in Poland this system is complicated. These conclusions encouraged authors to attempt to specify the causes or the very assessment of the effectiveness of vocational education in Poland in terms of labor market demand.

Structure of the paper

In this paper, we present a literature review in which we show differences between different system vocational education approaches, their pros and cons, and common systemic problems related to its elements. We describe the important influence and dependence on local industry and foreign capital, which may solve some of the problems, as well as bring new challenges directly connected with education returns in terms of labour. This helps us show importance of the factors which were used in the statistical analysis where we try to answer the question: does the Polish vocational education system properly meet the needs of the labour market? It also lets us focus on an attempt at finding important socio-economic elements that may help in answering that question. In the analysis, we use linear and logistic regression as well as spatial analysis of the measure of education effectiveness on the NTS-4 level proposed by authors of this paper. At the end of the article, a conclusion regarding the results is presented, and the possible role and behaviour of socio-economic measures is discussed.

Vocational education – some systemic problems

Vocational training is often perceived as a way of solving the problem of unemployment among young people. In view of numerous publications on the issue, three types of vocational training can be distinguished. These involve 3 separate systems: 1) vocational and technical schools, 2) formal apprenticeship and 3) dual systems [Eichhorst et al. 2015]. The authors of the above article suggest that the most efficient system would consist of dual training based on: a) employer support through apprenticeships, b) acceptance of apprenticeships as a training component that is characterised by lower wages but allows for the acquisition of new skills, c) support from the government in the form of additional funds, establishing frameworks for apprenticeships, external monitoring of results.

Each of the systems generates different problems. In the case of the dual system, the difficulties are connected with the aspect of responsibility for the student's safety during an apprenticeship. The status of employment itself plays a significant role in this situation. The authors of the article highlight that the status of either a student or an apprentice is an important factor that has an influence on health and safety measures, as well as the scope of a supervisor's responsibility [Grytnes et al. 2018]. A comparison of two dual systems, the Swedish and the Danish one, suggests that when participants have apprentice status, the teachers have limited contact with them. Danish participants with apprentice status consider supervisors from the workplace as more important in the process of acquisition of professional competences than the Swedish ones, who maintain their student status. At the same time, Swedish students feel safer in the context of work, while the Danish apprentices mention issues with their employers, who consider introducing safety measures as an extra expenditure.

One of the problems concerning training could be the level and the system of remuneration of teachers, which was mentioned in, among others, an extensive publication by Polcyn et al. (2017). The teachers' lack of motivation for self-development caused by inadequate distribution of funds can lead to a deterioration of students' results and therefore to their lower position on the job market. The discussion on the professional development of vocational teachers has been ongoing for many years. In her article [Saunders 2012], the author notices the need for teacher training and presents the results of such formation based on the example of 27 Australian teachers. The author emphasises the importance of creating teacher communities, exchange of experience and continuous cooperation. It helps in spreading innovation and cooperative problem solving, where an experienced teacher can act as a mentor for others. In Australia, as the author points out, no forms of introducing positive changes can be employed without sufficient financial means or effective planning. Change for the better, whenever it happens, is always multidimensional and, considering its high level of complexity, must be based on hard evidence and evaluation. Importantly, the author underlines that teachers are valuable human capital. The example presented in her paper could be an answer to the requirements set by the job market for vocational training, as well as the people responsible for its evolution, most of whom are vocational teachers.

In 2012, an analysis was conducted to investigate the influence of broadening the opportunities for training vocational school graduates through reduction of differences between academic and vocational development paths. Hall (2014) indicates in the article that despite a raise in interest in such training form, the solution did not have an influence either on interest in higher education or on the level of remuneration in the later career.

Therefore, every vocational training system raises questions and problems, as even the three-category divisionmentioned can be insufficient. Many publications [e.g. Prasad and Tran 2013] emphasise the need for the development of general education in combination with specific professional skills. This influences the future of students on the job market.

Already in 2007, Wendy Smits [Smits 2007] claimed that in the case of imperfect matching of the industry-oriented skills included in vocational curricula with job market requirements, employees prefer to receive a general rather than a socially optimal education. The reason for this is that the level of such education is decisive for the lower salary limit they receive after completion of training, regardless of whether they remain in the industry or not. It is the professions that require specific competences (with strong emphasis on their acquisition), not the more general ones, that are characterised by a higher risk of employment loss. This issue is much broader, and also connected with worker mobility [Katz and Ziderman 1990]. Through activities, industry itself tries to come to terms with the ecology towards sustainable development [Topor 2017] that is reflected in a greater awareness of employees, as well as potential students in the dual studies system, however, it is difficult to perceive this in the prevailing vocational training programmes in Poland.

A comparative analysis of vocational training methods in France [Bonnal et al. 2002] demonstrated that apprentices enjoy a significant advantage over vocational school students when looking for employment. In their analysis, the authors point out important socio-economic measures such as unemployment rate, ratio of number of employers to students, and diversification in the employment sector. The use of these measures was confirmed by the authors Franz and Zimmermann (2002). The analysis of the systems in Germany and Switzerland by Deissinger and Gonon (2016) indicates clearly that the dual training system, as well as vocational training itself, constitutes a cornerstone of economic wealth in these countries. This success is not only due to the efforts of government authorities, but also other institutions, trade unions and large companies.

The future of students – matched to the labour market and education returns.

The issue of financing vocational education and its expected effects also applies to the kind of return expected on investments in human capital back to a company, even in the case of employees already hired. Almeida and Carneiro (2009) indicate that, for the companies that participate in training, returns are significant, and hence, practical training in the enterprise provides returns comparable to either investments in physical capital or investments in schooling. In the article by Acemoglu and Pischke (2000), the authors analysed the impact of training certificates as providing an incentive to learn, such that employees want to get them

and that employers value them and therefore participate in the costs. They showed that the certification process is the only institutional feature that helps to support apprenticeship and further vocational training, in an economy like Germany.

Of course, in the case of education in Poland, it still largely depends on the means available to technical schools, that is, by generalising expenditure in district budgets for vocational education. The share of the capital of external companies may, however, have a completely different effect. It happens that employees who are prepared according to the skill-weights scheme (a kind of matching of skills), in case of the forced change of work, achieve lower incomes, with prior training focused on the skills necessary for a given company. In the case of the combination of specific features, such as the combination of medicine and law, loss of work will lead to a much greater reduction in remuneration in the next job [Lazear 2009]. If the skills are more general, that is, they occur among a large number of companies, and differ only in the level of their needs, the loss of earnings will be lower. In case of the bankruptcy of companies, there are additional problems for journeymen, as the authors of an analysis of such cases for Austrian companies show [Fersterer et al. 2008]. In the United States in 2005, the statement describing vocational education at high school level was made as preparing students for professions requiring small and outdated skills [High School Reform, Round 1 2005]. This argument, however, even at that time, was ruined by the results of research on wages showing a greater increase in earnings for the so-called blue collar workers over office workers. Research on the comparison of student education on vocational and academic paths at secondary school level in 1988 showed that students on the technical path would not profit by changing their path to the academic one [Meer 2007]. In those years there was a great "knowledge revolution", which we are also experiencing today, and which can even be observed in the Polish context in the case of the proper adjustment of vocational education, graduates of these schools can get higher earnings even than employees who were devoted to their education for many years, dedicating themselves to academic and didactic work at universities. In this context, in 2007, this author pointed out that vocational education should not be stigmatised or treated as an inferior education choice. The moment of transit to so-called early employment from school to work (immediately after graduation) was analysed on the example of Western Germany in an article by Brzinsky-Fay and Solga (2016). Several birth cohorts were used, deriving from many different areas in terms of macroeconomics. Despite the differences, it was found that this transition maintains a linear character. However, gender differences were noticed. Men who find themselves in the labour market earlier than women seem to be in a better situation. These results relate only to the German education system.

Especially in the case of self-employment, on the basis of the results of a situational analysis of education in Poland [Turczak 2017], disproportions between gender considering the vocational training may be observed.

Nevertheless, the influence of such education on the entire period of work capacity is still debatable, in which an employee often has to adapt to the changing labour market. At the same time, there are theories that education [Hanushek et al 2011] better prepares for such a situation, as well as theories that vocational education itself is better than education directly in the workplace during employment [Adda et al. 2006], however, it is difficult to define it clearly.

More complex analyses, taking into account long-term effects based on data from Great Britain before the Great Recession, show a close dependence between success on the labour market and family background characteristics (eg. parental education), which has a fundamental impact on labour market performance. What can be observed here is a growing socio-economic polarisation characterising the moment of transition from school to work [Dorsett and Lucchino 2014].

Using the data on the entry into the labour market of young Germans from the period 1984-90, another author showed interesting facts describing how young people manage to function on the labour market, depending on employment. He compared the experience of journeymen, university graduates, vocational and post-secondary schools. As a result of the data analysis, he noticed that journeymen who completed training did better in their first job than others. Among them, those who had been educated in larger companies were most likely to gain regular employment, however, once employed, the stability of their work did not differ from the stability of the work of young people coming from other schools. Nearly 70% of apprentices left the company that trained them within five years, which indicates that journeymen develop more general, transferrable features as part of their education, rather than being strictly focused on a specific company [Winkelmann 1996].

Vocational education and its various forms can be an important factor in the strategies of encouraging work, i.e. in the so-called activation strategies including ALMPs – active labour market programmes. Here, in turn, one of the dangers of interrupting such a course can be getting a job before graduating and obtaining a certificate. Vocational training is an important element of ALMP in countries such as Finland, Japan and Ireland. These programmes often oblige participants to obtain/search for a job right after completing the courses. In countries such as Switzerland, Australia or the United Kingdom, participants receive

jobseeker status during the courses. This support often also applies to people from groups of social exclusion (eg people with disabilities) [OECD 2013].

Foreign capital

It is not possible to omit the influence of companies from outside a country on vocational training. Foreign companies appearing in Poland often show a common tactic, they base the location of the firm depending on the available workforce that they ultimately educate themselves for their company needs. Because this approach most often requires specialisation, they choose a specific education that is strongly tailored to the company's profile. It is connected with financial outlays and, often, cooperation with local authorities, however, it results in effects which the employer has a strong influence on. Often, this also involves the use of specialists from the company as teachers, not only in the field of dual studies and focus on education directly in the workplace, but also through contact with practitioners directly in school classes. Thus, the nature of the company's contribution has not only a financial dimension, but also takes the form of investment by engaging its own staff in the entire process. Companies usually use (especially in the IT sphere) external certificates confirming the acquisition of competencies that are then necessary for employment (companies such as Quad, Alcatel, Atos, etc.).

Foreign companies operating in Portugal usually have a better educated workforce and pay higher rates, which allows them to closely control the quality of employees [Almeida 2007]. There is also a tendency to take over local companies that exhibit these desirable features. Mostly these are large companies that have an educated workforce and offer decent pay for people with lower education. Potential employees with a vocational education must see such employment opportunities as unique.

The exemplary research based on the analysis of data from the 1990s in Sweden by Bandick and Carpathians (2011), shows that the share of foreign capital significantly increases employment levels and, despite a clearly stronger effect for people who already have the skills necessary for companies, this effect was mainly related to large companies. The authors did not confirm the thesis that the participation of foreign companies reduces employment in any way. The effect is essentially the opposite. In the light of low loans which increases the growth in the number of local firms the effect may be even larger [Mitrovic and Ljubic 2015].

In the case of Poland, it is also worth noting that in a study analysing the period from 1995-2013 Strawiński et al. (2018) show that as a result of a significant reduction in the number

of vocational education graduates, their relative salaries and the need for such employees increased. These results are important for educational policy in Poland.

Concluding the review of the literature, it is worth mentioning at the end of this chapter about the tool created in Sweden in the 1990s which is one of the potential cures for the problems of labour and population migration, and at the same time predicting labour market parameters and enabling various types of evaluations. It has been successfully adopted in Finland and makes it possible to monitor the skills of the available workforce. The main parameters are, among others: developing future goals for the technological development of education, and innovation factors either accelerating or slowing down development. On the basis of these achievements, the Occupational Barometer was developed and described in greater detail in the article [Pitukhina and Sigova 2015], later it was also adopted in Poland.

Methods of analysis

The analysis of the effectiveness of vocational education on the non-tertiary level, in terms of labour market demand, began with the collection of information on vocational education courses on secondary and post-secondary non-tertiary level in Poland.

The fundamental document currently in force, regulating and describing this education is the Regulation of the Minister of National Education of March 13, 2017 on the classification of vocational education occupations [Journal of Laws of 2017, item 622]. The most important information for the study included in this document is determined by the names of the professions, ordered by groups, corresponding to the classification of professions and specialties for the needs of the labour market, areas of education (referring to the classification of the Polish Classification of Activities) to which professions are assigned, types of schools providing training in these professions and the names of qualifications that are assigned to them [Regulation of the Ministry of Education of 13 March 2017].

The second fundamental document used for the analysis was the Polish Classification of Occupations and Specialties. In this case, the document is based on the classification of occupations and specialties for the needs of the labour market from 2014 – uniform text [Journal of Laws of 2018, item 227]. It contains appropriate keys and names of occupations, allowing for specifying the main professional tasks [MRPiPS 2018; Regulation of 27 April 2010 and further; Regulation of the Ministry of Education of 13 March 2017].

In the next step, statistical data on the number of students in a district (NTS-4) were collected on the basis of the Local Data Bank (BDL) of the Central Statistical Office (GUS): secondary and post-secondary (non-tertiary) schools for young people (excluding special schools) using the narrow fields from the ISCED-F 2013 classification of programmes and

qualifications (International Standard Classification of Education introduced by the UNESCO Institute of Statistics for the European Commission, classifies educational programmes and related qualifications by fields and narrow fields of study (occupations are not directly related). Due to the fact that there is no direct link between the classification of occupations and the ISCED-F 2013 narrow fields of education (due to the large number of occupations), an attempt was made to link these values. This activity was carried out by Central Statistical Office staff from the Department of Social Research and Living Conditions Statistical Office in Gdansk. They proposed a key link (90 professions, afterwards, at the request of the authors and owing to the courtesy of the aforementioned Office, the key for most professions was made available) to connect ISCED-F 2013 with the classification of professions [GUS 2017]. This allowed the aggregation of data on the number of students trained according to the ISCED-F education courses in 2013. There are uncertainties about the fit of some professions using a detailed analysis of data resulting from the publication International Standard Classification of Education: Directions 2013 [POLON 2018; UNESCO 2015]. This publication indicates 12 large fields of education, as well as numerous narrow fields related to those used in the publication [GUS 2017]. Moreover, the UNESCO publication includes, in addition to descriptions, the examples of qualifications and programmes, as well as detailed narrow fields, with exclusions where some aggregates may overlap. Using this data, based on the knowledge derived from educational programmes [Regulation of the Ministry of Education of [March 13, 2017], Internet documentation [Ministry of Labour and Social Policy 2013) on standards of professional competences and professional qualifications and previously mentioned publications, the authors created a key (combination) of connections between 214 occupations of vocational education on the non-tertiary level and educational narrow fields ISCED-F 2013.

Data from this collection does not provide detailed information on the number of pupils per occupation within a district, however, for analysis based on the ISCED-F aggregation, this is sufficient.

The analysis also uses data from the recently created Polish Occupational Barometer [https://barometrzawodow.pl/]. These data are aggregated at the district level and relate to, among others, the relationship between the available workforce and the demand for employees. This document presents the aggregation to nearly 200 so-called “occupational classes” defined by the key links to the Occupations and Specialties Class (official Polish document) occupations in the documents [Occupation Barometer 2017] attachment. Each of the occupational classes is described by one of 5 features: “balance of demand and supply”,

"jobseeker's deficit", "large jobseeker's deficit", "surplus jobseekers", "large surplus of jobseekers". For simplicity, aggregation into three groups was made: deficit, surplus and balance.

Since the most important information for the analysis is information on deficit professions covered by education in vocational schools, the occupational classes were linked to the Occupational Barometer through the aforementioned key with occupations in the Classification of Occupations and Specialties, and then with the key from this classification to ISCED-F 2013 and for this aggregation two sets of data were prepared. One contained the percentage of the number of occupational professions related to the ISCED-F 2013 education narrow field, in the total number of occupations listed in the Occupational Barometer (i.e. the number of professions in deficit, surplus and balance) in a given district, in a given narrow field of education in the ISCED-F 2013 classification. The second set of data contained the number of deficit occupations in a district in a given narrow field.

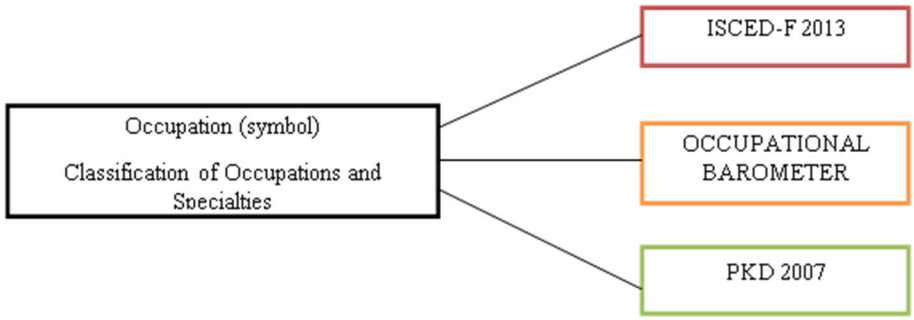
Using the prepared key connections, it was possible to link the professions resulting from the Classification of Occupations and Specialties with sections of the Polish Classification of Business Activities 2007 (PKD). This connection was made taking into account inaccuracies resulting from the fact that in the case of establishing a business there is, despite legal restrictions, a certain freedom resulting from the individual insertion of PKD codes by people setting up a business. At the same time, there are inaccuracies resulting from the fact that when determining the PKD code of larger companies with several activities, the activity constituting the largest share in the global operations of the company is taken into account and the remaining ones are omitted. It was assumed that vocational education aims to educate people for a particular profession and for isolated cases only it was assumed that they would work in an enterprise not belonging to the broad areas of the PKD (sections). In addition, in the case of professions which are difficult to assign, the previously mentioned documentation was used, including the Professional Competency Standards and Professional Qualification Standards [Ministry of Labour and Social Policy 2013]. In this document, the current Ministry of the Family of Labour and Social Policy[1] describes the qualifications and professional competences for the professions listed there, often giving the classification of PKD directly. In some cases, the occurrence of the PKD code of a given activity was also analysed directly in available business bases.

This resulted in dictionary key links between all the aforementioned classifications.

[1] Current ministry name after change that was introduced in 16 November 2015.

In addition, data on budget revenues from districts were used according to the budget classification from the Local Data Bank of the Central Statistical Office per person for 2016, however, it only approximately corresponds to the PKD. Since the PKD groups occurring in it are repeated, it was decided not to bind them directly with the key, and use them as an additional indicator that can determine the choice of the right narrow field of education in a given district [Ministry of Culture and Trade Regulation July 21, 2017.

Fig.1. Diagram of connections between used databases



Source: own study.

Linear modelling and additional data

Firstly for linear modelling, the 5 most numerous narrow fields, in terms of student numbers, in Poland, within ISCED-F 2013 were used: architecture and construction, engineering and engineering trades, personal services, manufacturing and processing, business and administration, and additionally an aggregation of these groups into one were taken into account. Apart from this, the modelling for narrow field of agriculture was made. The data used for each model were first standardised. In the process of cleaning, data with incomplete attributes, missing elements and outliers were removed from district datasets. There were 339 observations used to create the models.

Modelling was performed using a linear model with heteroscedasticity correction, taking into account the collinearity criterion and analysing p values (Gretl software).

The variables that were taken into account, corresponding to the district level data (NTS-4) for 2016, are:

Table 1. Table of variables used in linear modelling

R0	**Number of students currently in education in a given narrow field of ISCED-F 2013 education divided by the number of people aged 15-19 (explained variable)**
R1	Expenditure of district in secondary and post-secondary non-tertiary vocational schools budget chapter divided by the total number of students in these vocational schools
R2	Percentage of people working in one of 5 groups according to the Polish Classification of Activities aggregated into 5 groups among total employees. The groups were: 1) financial and insurance

	activities; real estate market services 2) trade; repair of motor vehicles; transport and storage management; accommodation and catering; information and communication 3) other services 4) industry and construction 5) agriculture, forestry, hunting and fishing,
R3	**Percentage deficit ratio of vocational education occupations from the Occupational Barometer for a given ISCED-F 2013 narrow field (described in the methodology)**
R4	**Number of vocational education occupations in deficit from the Occupational Barometer for a given ISCED-F 2013 narrow field (described in the methodology)**
R5	Revenue of the district according to the Budgetary Classification sections of districts divided by the number of people of working age
R6	The number of business entities (aggregation according to the Polish Classification of Activities) divided by the number of people of working age
R7	Value of gross fixed assets in millions of zloty (by the Polish Classification of Activities – aggregated into 5 groups as in R2) divided by the number of people of working age
R8	Investment outlays in millions of zloty (by the Polish Classification of Activities – aggregated into 5 groups as in R2) divided by the number of people of working age
R9	Percentage of unemployed with post-secondary and secondary (non-tertiary) vocational education in general
R10	The number of foreign capital entities divided by the number of people of working age
R11	The amount of foreign capital in Polish zloty per working age population

Source: own study.

Description of individual models

Table 2. Values of linear model coefficients with p values for architecture and construction

Variable	coefficient	Standard Error	t-Student	p value
const	0,01	0,04	0,19	0,85
R1	−0,39	0,05	−8,04	0
R6	0,1	0,04	2,42	0,02
R9	0,27	0,04	6,58	0

Source: own study.

In the model, in which the explained variable describing the ISCED-F 2013 architecture and construction narrow field, significant explanatory variables that fulfil the role of stimulant in the model, are: a coefficient describing the number of entities in section F of the PKD (construction) (R6) and a coefficient with almost three times greater value than the previous one (R9), i.e. the share of unemployed with a vocational education, among the unemployed in total. The destimulant is the coefficient referring to expenditures in the vocational school of the district budget chapter (R1), it is the strongest effect with a value close to -0.4.

The increase of this coefficient (R1) by unit decreases the explained variable, i.e. the standardised coefficient describing the scale of education in the architecture and construction subgroup by about 0.4 units.

Factors describing occupational deficits (R3 and R4) showed too high a value of parameter p and were omitted as insignificant, they also showed collinearity. The remaining coefficients were eliminated due to collinearity or too high a value of parameter p. The presented model is characterised by values of $R^2 = 0,25$ and for F test, F (3,335) = 37,7 with p value = 0.

Table 3. VIF values for the architecture and construction narrow field model

Variable	VIF
R1	1,02
R6	1,01
R9	1,01

Source: own study.

Narrow field: engineering and engineering trades

Table 4. Values of linear model coefficients with p values for a narrow field: engineering and engineering trades

Variable	coefficient	Standard Error	t-Student	p value
Const	0,05	0,05	0,98	0,32
R6	0,41	0,09	4,43	0
R7	0,56	0,09	6,2	0
R8	−0,15	0,05	−2,87	0
R9	0,13	0,04	3,35	0
R11	−0,26	0,1	−2,72	0

Source: own study.

For the ISCED-F 2013 engineering and engineering trades narrow field, the relevant explanatory variables in this model are: (R9) an indicator describing the share of unemployed with vocational education in the total unemployed, which is the smallest of them, with a value of approximately 0.13, (R6) a coefficient describing the number of entities in section M PKD (professional, scientific and technical activities) acting as stimulants with values of about 0.41,

(R7) a coefficient describing the value of gross fixed capital formation per entity according to the aggregated classification of PKD – industry and construction, with the highest stimulant value of around 0.56. The strongest destimulant here is (R11) the coefficient describing the amount of foreign capital per capita (value approx. -0.26), and following it the coefficient (R8), describing investment outlays per person of working age with a value close to -0.15.

The increase in (R7), the largest coefficient by unit, results in an increase in the explained variable, i.e. a standardised coefficient describing the scale of education in the engineering and engineering trades narrow field by about 0.56 units.

The remaining coefficients were eliminated due to collinearity, or too high a value of parameter p. The presented model is characterised by values of $R^2 = 0,24$ and for F test, F (5,333) = 20,5 with p value = 0.

Table 5. VIF values for the engineering and engineering trades narrow field

Variable	VIF
R6	1,531
R7	1,858
R8	1,523
R9	1,038
R11	1,451

Source: own study.

Narrow field: personal services

Table 6. Values of linear model coefficients with p values for the narrow field: personal services

Variable	coefficient	Standard Error	t-Student	p value
const	0,01	0,05	0,29	0,78
R3	-0,12	0,04	-3,16	0,00
R5	-0,27	0,09	-2,98	0,00
R6	0,61	0,06	9,76	0,00
R9	0,17	0,04	4,44	0,00

Source: own study.

In the model for the next narrow field (personal services) two stimulants and two destimulants can be distinguished. Again, as in the previous model, the coefficient describing

the participation of deficit professions (R3), despite the fact that it has a size of p that allows it to be distinguished in the model, is destimulating (value approx. -0.12). Of similar character, but more than twice as large, is the R5 coefficient, describing the size of district income resulting from chapter 710 – services for the population according to the Budgetary Classification. In the case of stimulants, there are, again, the variables R9 and R6, which are the indicators describing the share of unemployed with vocational education among the unemployed, and the coefficient describing the number of entities in section S of the PKD (other services activities), which is dominant here, being almost 4 times larger than R9.

The increase of this coefficient by unit results in an increase in the explained variable, i.e. a standardised coefficient describing the scale of vocational education in the narrow field of personal services by about 0.61 units.

The remaining coefficients were eliminated due to collinearity or too high a value of parameter p. The presented model is characterised by values of R^2 = 0,27 and for F test, F (4,334) = 30,2 with p value = 0.

Table 7. VIF values for the model of narrow field of personal services

Variable	VIF
R3	1,12
R5	1,02
R6	1,14
R9	1,01

Source: own study.

Narrow field: agriculture

Table 8. Values of linear model coefficients with p values for the agriculture narrow field

Variable	coefficient	Standard Error	t-Student	p value
Const	-0,02	0,05	-0,42	0,68
R6	0,43	0,06	6,96	0,00

Source: own study.

In the model for the narrow field of agricultural education, in principle one stimulator is distinguished, which is the coefficient describing the number of entities in section A of PKD (agriculture). The increase of this coefficient by unit results in an increase in the explained

variable, i.e. a standardised coefficient describing the scale of education in the subgroup of Agriculture, by about 0.43 units.

The remaining coefficients were eliminated due to collinearity or too high a value of parameter p. The presented model is characterised by values of R^2 = 0,13 and for F test, F (1,337) = 48,8 with p value = 0.

Narrow field: business and administration

Table 9. Values of linear model coefficients with p values for the narrow field business and administration

Variable	Coefficient	Standard Error	t-Student	p value
const	0,074	0,05	1,46	0,15
R1	−0,27	0,06	−4,48	0
R2	0,26	0,09	2,8	0

Source: own study.

This model is clearly different from the previous ones. The coefficient referring to expenditures in the vocational school budget chapter for districts (R1) (with a value of about -0.27) is a destimulant here. A strong stimulant here is the ratio, pre-existing in previous models, describing the percentage of people employed in the aggregate PKD department "financial and insurance activities; real estate market service" (R2).

The increase of this coefficient by unit results in an increase in the explained variable, ie a standardised coefficient describing the scale of education in the narrow field of business and administration by approx. 0.26 units.

The remaining coefficients were eliminated due to collinearity or too high a value of parameter p. The presented model is characterised by values of R^2 = 0,15 and for F test, F(2,336) = 31,5 with p value = 0.

Table 10. VIF values for the narrow field of business and administration model

Variable	VIF
R1	1,56
R2	1,56

Source: own study

Narrow field: manufacturing and processing

Table 11. Values of linear model coefficients with p values for narrow field of manufacturing and processing

Variable	coefficient	StandardError	t-Student	p value
const	-0,03	0,05	-0,51	0,61
R1	-0,3	0,05	-6,08	0
R2	0,29	0,05	6,14	0
R10	-0,2	0,06	-3,22	0

Source: own study.

In the next model, we notice significant variables, of which only one is a stimulant. It is the percentage of people employed in the aggregate PKD "industry and construction" department with a value of around 0.29 (R2). The remaining destimulants are the previously occurring (R1) ratio, referring to expenditures in the vocational school chapter of district budgets, with a value of around -0.3 and the previously absent ratio (R10) describing the number of foreign capital entities divided by the number of residents of working age (value approx. -0.2).

The coefficients R2 and R1 have almost identical values, but opposite signs. When they increase by a unit, they cause, respectively, an increase or decrease in the explained variable, ie a standardised coefficient describing the scale of education in the narrow field of manufacturing and processing for the population by approx. 0.3 units.

The remaining coefficients were eliminated due to collinearity or too high a value of parameter p. The presented model is characterised by values of R^2 = 0,18 and for F test, F (3,335) = 25,8 with p value = 0.

Table 12. VIF values for the narrow field of manufacturing and processing model

Variable	VIF
R1	1,1
R2	1,1
R10	1,18

Source: own study.

Narrow field: data aggregation without agriculture

Table 13. Values of linear model coefficients with p values for data aggregation without agriculture

Variable	coefficient	StandardError	t-Student	p value
const	0,23	0,02	9,50	0
R1	−0,32	0,02	−19,62	0
R2	0,29	0,03	11,20	0
R6	−0,25	0,02	−11,59	0
R8	−0,04	0,01	−3,14	0
R9	0,09	0,02	4,87	0

Source: own study.

The last model uses the aggregated data from the previous models, omitting agriculture, which clearly stands out from the others on account of the small number of educated students in Poland – 11,480. The linear model based on the agriculture narrow field contained only one explanatory variable.

The destimulants present in this model are the following variables: (R1) the coefficient referring to expenditure on vocational schools in the budget chapter (value approx. -0.3), (R6) the coefficient describing the number of entities in the corresponding PKD section per person of working age and (R8) the coefficient describing investment expenditure per person of working age, with values of -0.25 and -0.04 respectively. In the case of stimulants, we have: (R2) describing the percentage of people employed with vocational education (non-tertiary) in the aggregate department of PKD with a value of 0.29, and (R9) the indicator describing the share of unemployed with vocational education among the unemployed, with a value of 0.09.

The increase in the strongest stimulant factor (R2) by a unit causes an increase in the explained variable, i.e. a standardised coefficient describing the scale of education in the data aggregation without agriculture by about 0.29 units.

The remaining coefficients were eliminated due to collinearity or too high a value of parameter p. The presented model is characterised by values of R^2 = 0,25 and for F test, F(5,1689) = 113,6 with p value = 0.

Table 14. VIF values for the data aggregation without agriculture model

Variable	VIF
R1	1,03
R2	1,78

R6	1,56
R8	1,22
R9	1,03

Source: own study.

Coefficients summary

Table 15. Comparison of the values of linear models' coefficients

Variable	Number of occurrences	Frequency	Destimulant	Stimulant
R1	4	57%	4	0
R2	3	43%	0	3
R3	**1**	14%	1	0
R5	1	14%	1	0
R6	**5**	**71%**	**1**	**4**
R7	1	14%	0	1
R8	2	29%	1	1
R9	**4**	**57%**	**0**	**4**
R10	1	14%	1	0
R11	1	14%	1	0

Source: own study.

As can be seen in table 15, the most important coefficients occurring in the models are R6, R9 and R1, which are the corresponding factor for the number of entities according to the corresponding PKD section, the coefficient corresponding to the share of unemployment with vocational non-tertiary education in general unemployment and the ratio referring to expenditure in the vocational schools district budget chapter per student. In most models, these variables are significant. For R6 and R9, almost every time they occur, they are factors stimulating the explained variable, only once a non stimulating factor can be seen for the data combined without agriculture. In the case of R1, it is always destimulating. Additionally, in three models there is a stimulating factor corresponding to the percentage share of the structure of people working in a given group of the corresponding aggregated PKD classification.

Very rarely, a significant deficit ratio resulting from the Occupation Barometer can be seen. When it occurs, its character is destimulating (!). This may indicate a lack of dependency

between the demand for a group of professions from the ISCED-F 2013 education narrow field and the number of students educated in a given field of study or, worse, the destimulating character of that variable.

Modelling using logistic regression

The logistic regression method has been in use for many years in many different fields of science, not only economics [for example: Menon 1998]. In short, the representation of a dependent variable as a binary value (0,1) is needed. In the process, we try to predict and explain the relation between one dependent binary variable and independent variables that can be nominal, interval, ratio level and many more. It is used to determine the probability, for example, of the possible answers yes/no, and the influence on that of the variables used. It can therefore be used in determining the probability of classification observations between two groups. In the method, it is important to avoid outliers in data, as well as collinearity between data.

The authors assumed that the effectiveness of vocational education can be evaluated through analysing cases in which there is a deficit in a given occupation belonging to a given narrow field of the ISCED-F 2013, and at the same time there is vocational education in that field (R0> 0 and R3> 0). This situation should be evaluated positively (variable value=1), when there is no deficit or education (R0 = 0 and R3 = 0), and negatively in the absence of such education with the occurrence of a deficit, or the reverse situation, that there is education, but there is no deficit (variable value=0). In addition, it was assumed that the ratio of the number of students enrolled divided by the number of people aged 15-24 must be at least 3% – otherwise we consider education as negligible, perhaps extinguishable or unprofitable. As a result of these activities two similar sized groups were obtained. R modelling software was used for the modelling process.

Table 16. Summary of logistic regression model coefficients

Variable	Odds ratio	p value
Intercept	1,29	0
R1	0,633	0
R2	2,17	0
R6	0,546	0
R8	0,72	0

R9	1,24	0
R10	1,46	0

Source: own study.

Based on the results, it can be stated that R2 is the strongest factor, i.e. the percentage of employed persons with vocational education in the aggregated PKD department. The increase of this value by one unit, while keeping the others with a fixed value, increases the chance of being in a positive group by as much as 117%. The remaining variables R9 – describing unemployment and R10 – foreign capital, respectively, increase the chances by 24% and 46%.

The growth of variables R1, R6 and R8, related respectively to expenditure on vocational education, the number of business entities and the share of foreign capital, cause a decrease in the chance of getting into the positive group.

In addition to the variable R10, which does not appear in the linear model, these results coincide with the 7th linear model, i.e. the aggregation of the data without the agriculture narrow field. The remaining models, including p and the collinear criterion, behave in most cases similarly to the stimulatory or destimulating character found in the corresponding variable models. A more detailed analysis of each narrow field of education is shown separately below. The results presented in the table all have p values <0.05:

Table 17. Values of logistic regression coefficients for 5 narrow fields of the ISCED-F 2013 education classification

Narrow field	**Variable**	**Odds ratio**
architecture and construction	(Intercept)	0,46
architecture and construction	R1	0,53
architecture and construction	R2	1,65
architecture and construction	R9	1,68
business and administration	(Intercept)	0,78
business and administration	R1	0,62
business and administration	R10	1,97
engineering and engineering trades	(Intercept)	8,34
engineering and engineering trades	R1	0,31
engineering and engineering trades	R2	2,72

Narrow field	Variable	Odds ratio
engineering and engineering trades	R8	0,70
manufacturing and processing	(Intercept)	0,08
manufacturing and processing	R1	0,65
manufacturing and processing	R2	2,50
manufacturing and processing	R9	1,66
personal services	(Intercept)	3,79
personal services	R1	0,66
personal services	R2	7,33

Source: own study.

Table 18. Summary of the characteristics of the logistic regression model coefficients from the 5 narrow fields of ISCED-F 2013 education and the aggregated group

Variable	Increases chance	Decreases chance
R1	0	6
R2	5	0
R6	0	1
R8	0	2
R9	3	0
R10	2	0

Source: own study.

Logistic regression models seem more unambiguous than linear regression modelling. The character of all variables appearing in models, increasing or decreasing depending on the explained variable, is always the same. From the results we are able to see that the variable determining expenditures in district budgets in the vocational education chapter, unfortunately, indicates that its increase does not mean a greater chance of being in the positive group. Actually, the reverse is true. There is an increase in the chances if there are more foreign capital entities (R10) and an increased percentage of people employed in the corresponding aggregated PKD group (R2). The variable (R8) describing investment outlays, unfortunately, unambiguously reduces the chance for two models, namely: the engineering and engineering trades narrow field of education and the data aggregation model. Again, the variable R9 describing the share of unemployed people with vocational education in general unemployment increases the chance of finding a positive group, which is a very specific result.

The dominant variable in previous linear models, R6, describing the number of business entities in logistic regression models, is much less common. It appears only once for the aggregated data group, reducing the chance of being in a positive group if its value increases.

Conclusions from the analysis of the models

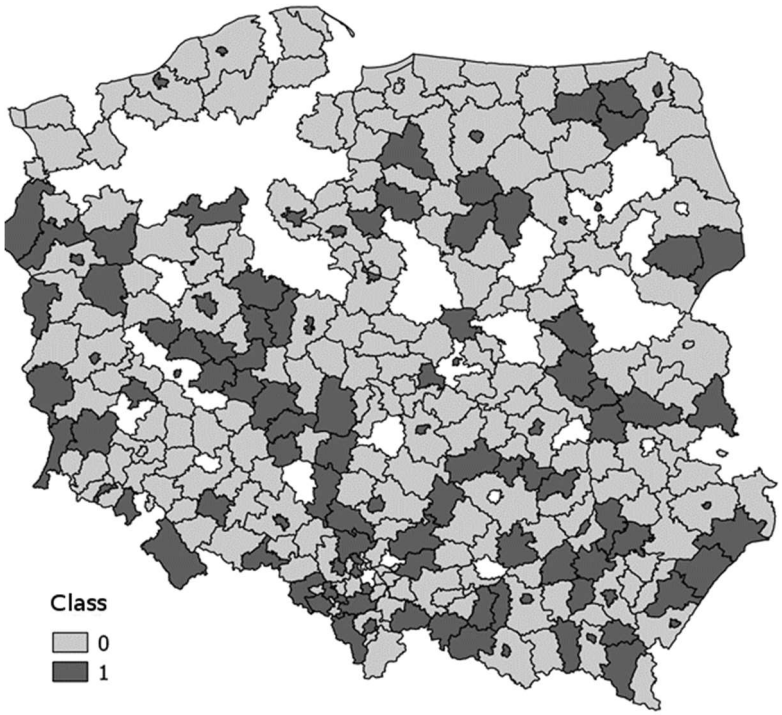
It seems that defining the effectiveness of vocational education as a link between the scale of education in ISCED-F 2013 narrow fields and labour market demand resulting from the occupational barometer, presented as a number of deficit professions or their percentage share (their dependence in models seems to be mostly linear), can serve as an important indicator in the analysis of the education system vocational training in Poland. Both linear and logistic regression models achieved similar results with significant character.

Due to its wide variety, it seems difficult to clearly assess the effectiveness of vocational education in Poland, even taking into account only 6 out of the 14 narrow fields of ISCED-F 2013 education. The differences between its individually defined narrow fields containing different occupations and the general tendency (data aggregation) can be large. Nevertheless, some common features of these models emerged. In the case of destimulants, we can see that the coefficient referring to expenditure in the chapter on vocational schools per student (R1), remains mostly at a value in the vicinity of -0.35. On the other hand, in the case of stimulants, the percentage of people employed in the aggregated PKD (R2), maintains its value around 0.28 and the share of unemployed with vocational education, among the total unemployed (R9), fluctuating between 0.09 for the aggregated data, 0.13 for the engineering and engineering trades narrow field, and 0.27 for architecture and construction. There is no dependence on the labour market or destimulating character of variables referring to occupational deficit (R3 or R4) for the linear models. The coefficient describing the number of entities in the corresponding PKD section per person of working age (R6) occurs most frequently. For models of four different subgroups of ISCED-F 2013, it is a stimulant and ranges from 0.1 for the narrow field of architecture and construction to 0.61 for the narrow field of personal services, however, for the aggregated data, it works destimulatively, at a level of -0.25. Other variables occur individually, or do not have a clearly defined role in the models.

Graphic representation of the proposed classification results

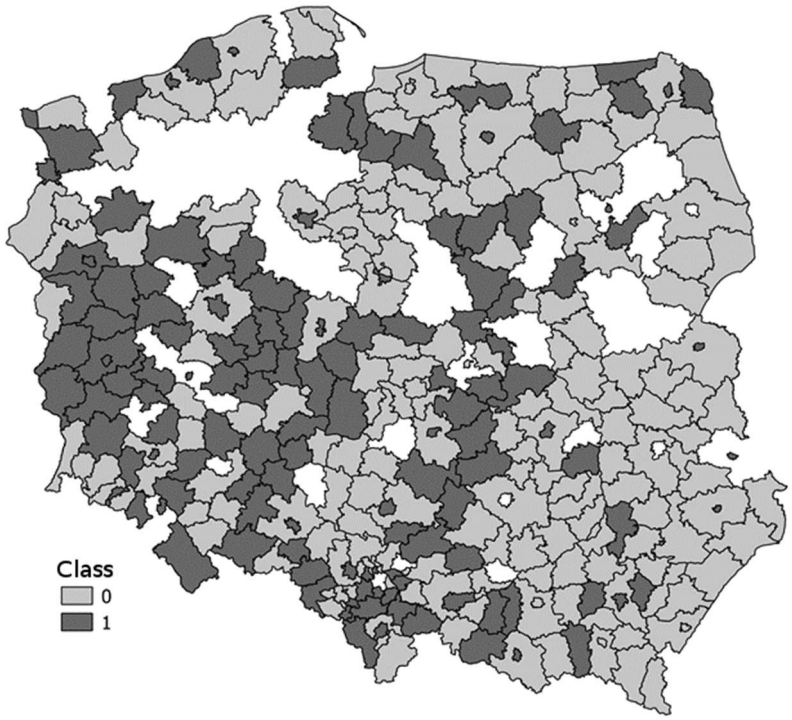
The following figures show a graphic layout of the distribution of districts with classes 0 (negative adjustment) and 1 (positive fit), for 5 narrow fields of ISCED-F 2013 on the map of Poland for the districts which were used to create the models. Qgis software was used to create the images.

Fig. 2. Classification of districts according to the classification of educational effectiveness for the education narrow field: architecture and construction.



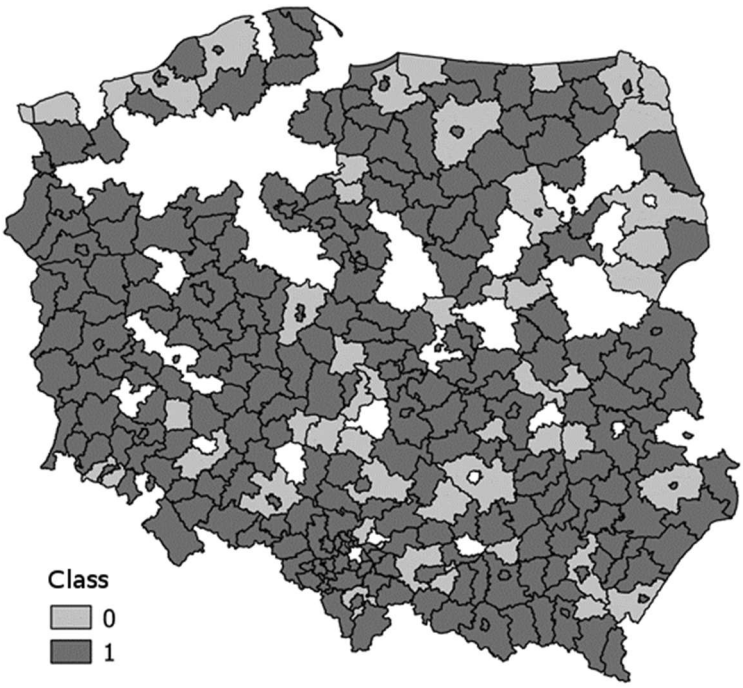
Source: own study.

Fig. 3. Classification of districts according to the classification of educational effectiveness for the education narrow field: business and administration



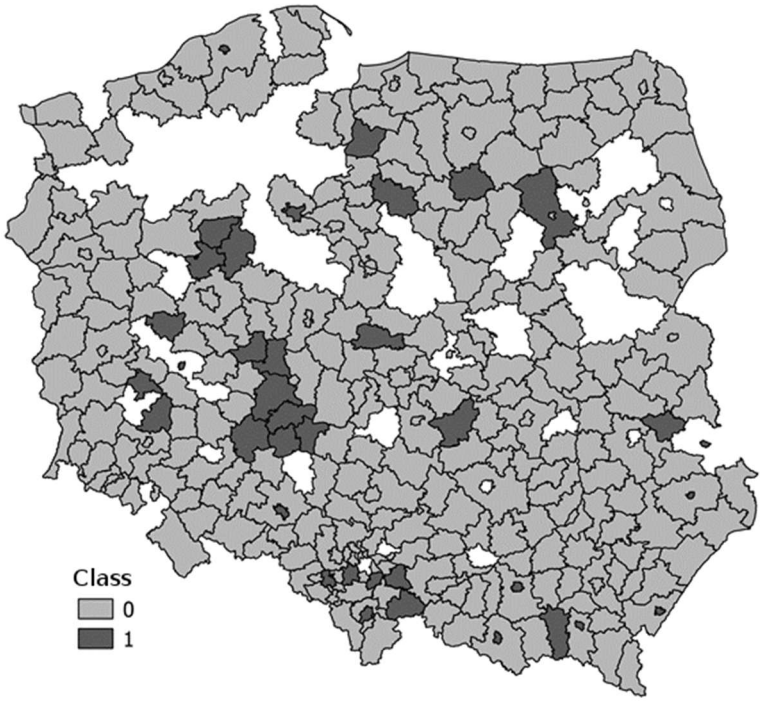
Source: own study.

Fig. 4. Classification of districts according to the classification of education effectiveness for the educational narrow field: engineering and engineering trades



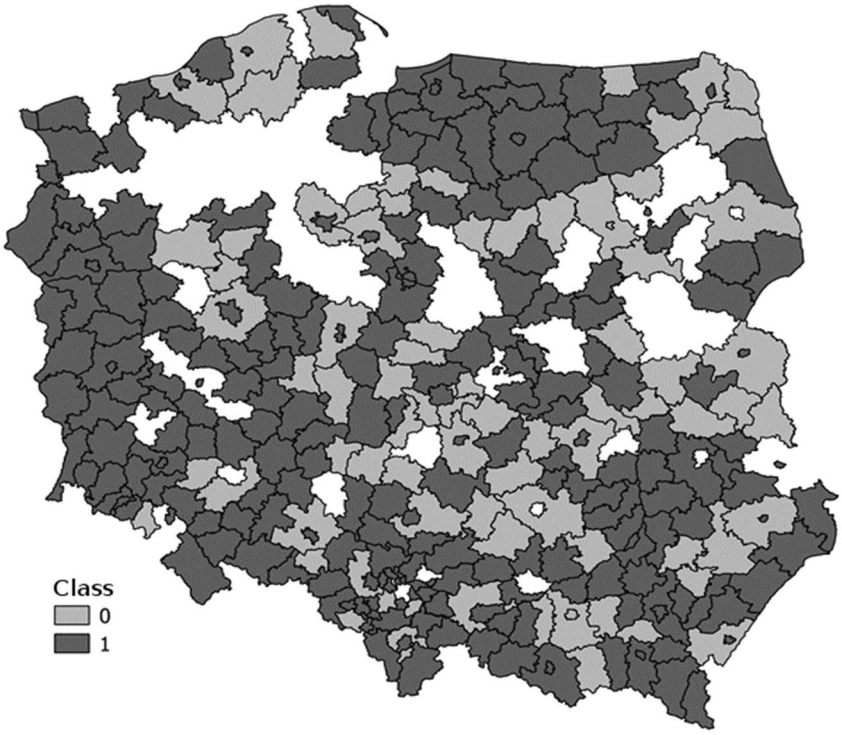
Source: own study.

Fig. 5. Classification of districts according to the classification of education effectiveness for the educational narrow field: manufacturing and processing



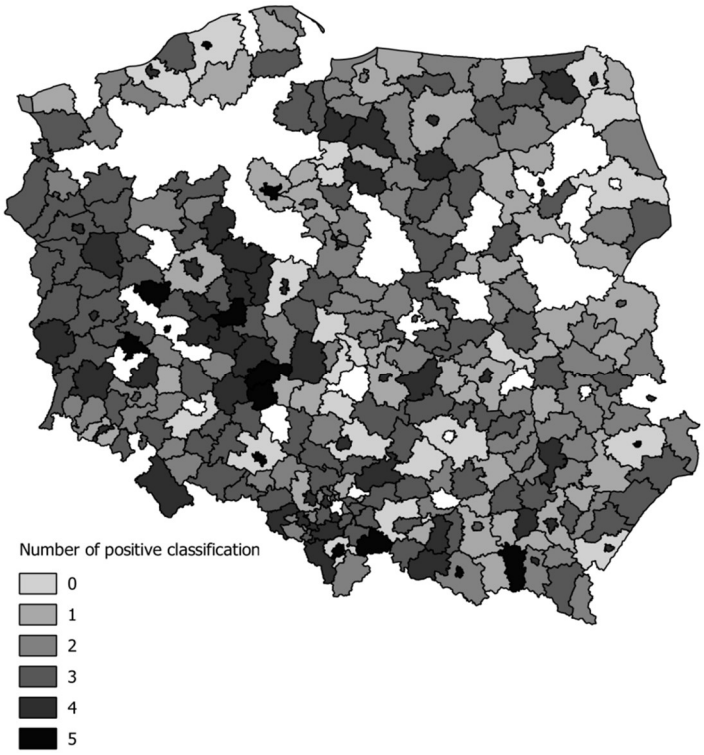
Source: own study

Fig. 6. Classification of districts according to the classification of educational effectiveness for the education narrow field: personal services



Source: own study.

Fig. 7. Classification of districts according to the classification of educational effectiveness: sum of positive classifications



Source: own study.

In the graphic presentation of the classification on the map of Poland, only in the case of the narrow field of business and administration education does it seem to be clearly shown that the concentration of the positive classification is clearly on the western side of the country. Other groups do not seem to stand out in the context of spatial distribution on the map of Poland in any way. The presented maps show, however, that the narrow field of production and industry education seems to be the worst in terms of matching the labour market. There are very few districts that have been classified positively. The situation is the opposite in the case of the engineering and engineering trades narrow field, where a positive classification in almost all Polish districts seems to dominate. Also positively, although to a lesser extent, the situation looks like in the case of a narrow field of personal services. In the case of other groups, the negative classification dominates.

Aggregation of data from Figures 2-6 is shown in Figure 7. We can see here that the most often positive classification of districts occurs in West-Central Poland. It is not unequivocal, but it seems that in the western part of Poland, however, the rather good adjustment of education to the demand of labour market in comparison with the eastern part prevails.

Models' implications and literature comparisons

As a result of the methods used, we can identify the factors that have the biggest impact on the effectiveness of vocational education. The expenditure of districts in the secondary and post-secondary non-tertiary vocational schools budget chapter divided by the total number of students in these vocational schools (R1) is a factor that can (and should), directly result in increased wages of teachers [Polcyn et al. 2017] and their development possibilities [Saunders 2012] as well as the advancement of standards of infrastructure accessible to students, and thus their effectiveness on the labour market. Since it can be seen in the presented models that, contrary to expectations, it works as a destimulant, this might imply a very big problem with the system as well as possibly a large issue on the level of the management of individual and general vocational school governance that does not cause a positive effect on educational effectiveness. This seems to be the most important conclusion.

The percentage of people working in one of 5 groups (R2), according to the Polish Classification of Activities aggregated into 5 groups among total employees, is a factor that describes the situation of the labour market directly surrounding students. The continuation of industrial development in terms of human capital seems to represent the natural order, and as such we can see in the models that it also increases the chances of a good fit to labour market demands. The "labour tradition" is visible around the world [Soutero-Otero et al. 2012]

(example of Japan – oldest trades/firms, as well as Germany [Deissinger and Gonon 2016]) and we can clearly see from the results that it also may be taking place in the analysed regions.

The next variable (R6), which is the number of business entities (aggregation according to the Polish Classification of Activities) divided by the number of people of working age, which in a way shows the "density" of business type, perhaps should, in a way, exhibit the same behaviour as the previous one. In fact, almost all the linear models presented do so (although in the logistic regression models we do not see many significant results), only one shows a decrease in the chances of a positive result. It may seem that the effects may be mixed or unclear, since we are dealing here with a more detailed and direct classification of activities than in the previous variables, which may result in a larger error. It also seems to be less significant than the other ones shown in this chapter.

The percentage of unemployed with post-secondary and secondary (non-tertiary) vocational education in general (R9) may be seen as the rate of unsuccessful education returns, or, in a way, a saturated labour market. It is clear from the results of the models that we cannot see a logical relation taking place in the analysed data, such as, for example, low numbers of students in an ISCED-F 2013 narrow field related to occupations with high unemployment. On the contrary, we see an increase in the chances of a positive effect, but also an increase in the number of students in vocational education. This may refer to the "inertia effect" where we see schools training students in occupations no longer needed [Attwell 1997]. From the models, we can derive that this might be a huge issue in the current situation in Poland.

The number of foreign capital entities divided by the number of people of working age (R10) stands for the interest of foreign capital in a presented area as it may be seen by many authors [Bandick and Carpathians 2011, Almeida 2007 and many others], investment in local society and human capital. In the presented models we see this exact behaviour, increasing the chance of a positive fit of vocational education to labour market demands and an increase in student numbers. This may suggest there are no problems in this field of analysis regarding the situation in the Polish vocational education system.

Conclusions

The presented analysis shows that it is not currently possible to confirm the existence of a positive relationship between labour market demand and vocational education at the secondary level indicating the effectiveness of such education.

The developed models may lead to contradictions. The increase in scale of vocational education in a given narrow field of the ISCED-F 2013 classification also seems to indicate that in a given district the share of those unemployed with vocational education among all those

unemployed will increase, while at the same time employment in the corresponding aggregated group will rise. The destimulating character of the variable R1 may at the same time result from the effect of scale (i.e., lower costs of education per student in larger centres), and at the same time indicate the diffuse nature of this education and the large number of small centres, which may affect its unprofitability and lack of relation to the labour market.

Despite the spatial analysis for engineering and engineering trades, it can be seen that across almost the whole country there are "positive" relations between labour market demands and the scale of vocational education, it is still hard to clearly determine if the system of education produces precisely the skills and competences needed by the companies in the labour market.

The great diversity and specificity of each of the narrow fields of education indicates rather its individual problems and possibilities. The speed of technological development of the corresponding fields also does not seem to be the same, and thus the rate of demand for innovation and changes in education programmes may be different. It may be worth noting here that even though innovation usually results from cooperation with industry, at a time when vocational training on a non-tertiary level is more controlled and ordered by the government, it has begun to lose importance for academic centres and higher education [Toner and Woolley 2016]. The very phenomenon of innovation in vocational education on a European scale still remains inconsistent and differs between countries of the European Union.

The current situation of vocational education in Poland, combined with the decrease in the number of students which causes an increase in the wages of people with such an education, makes it difficult to unequivocally assess whether education is properly adapted to the labour market and whether it is effective in this sense. For example, taking into account the discussion about the relation of the amount of content of "general education" in vocational education to education focused on a specific occupation, or, as in the case of dual education, focused on the skills needed for a given company. Even though the proposed changes can be positive, still in some cases determine a kind of polarisation of education and lower flexibility of students competences in the labour market. However, one can not deny the existence of a large influence of foreign capital on these phenomena. The topic certainly requires more detailed analysis, perhaps, as some authors propose, also a direct examination of the paths of employment of individual students (tracking) and a deeper analysis of the cooperation of the environment (companies and institutions) with vocational education at secondary level in Poland.

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