ISSN 1822-8038 (online)
INTELLECTUAL ECONOMICS
2019, No. 13(1)

CHANGES IN THE OCCUPATIONAL STRUCTURE OF THE LABOUR MARKET IN POLAND IN 1995-2016

Adam P. BALCERZAK
Department of Economics, Nicolaus Copernicus University in Toruń
ul. Gagarina 13a, 87-100 Toruń, Poland
e-mail: adam.balcerzak@umk.pl

Artur GAJDOS
Department of Spatial Econometrics, University of Łodz
ul. POW 3/5, 90-255 Łódź, Poland
e-mail: artur.gajdos@uni.lodz.pl

DOI: 10.13165/IE-19-13-1-03

Abstract. *Within last few years Polish labour market has undergone significant structural changes, where the main labour markets policy challenges moved from the problem of fighting unemployment to the problem of labour market shortages and the issue of increasing allocation effectiveness of labour force. This situation creates the need for building new and updating the existing quantitative diagnostic tools that can be useful for providing labour market policy guidelines. As a result, the main objective of the article is to conduct re-specification of the occupational model for major occupational groups with a high adjustment to empirical data and good statistical properties, which could be applied for forecasting purposes. To fulfil the aim of the article the causal model econometric model for major occupational groups in Poland in the years 1995-2016 was re-specified. From the forecasting perspective the obtained model is currently the most updated tool with respect to the occupational structure in Polish labour market, which in the same time is characterised with sufficient statistical quality. From the economic perspective the research confirms the process of modernisation of Polish economy and the structural changes that are conducive to the tendencies observed in the EU-27 countries.*

Keywords: *major occupational groups, occupational structure, labour markets, causal model, Poland*
JEL Codes: *E24, C51*

Introduction

The process of economic transformation from central planned to market economy, which was the common experience for Central and Eastern European economies, have seriously changed all socio-economic fields of these societies. Within this respect all economic relations have been redefined and it can be said that in many cases all the economic markets including market of goods, financial markets and labour market were build form the beginning. However, almost for all the Central European countries the biggest burden of the structural transformation was seen in the case of the labour market, which in the same time has the biggest importance for socio-political stability of all societies (Bieszk-Stolorz & Markowicz 2015; Kopycińska & Kryńska, 2016). That situation could be especially noticed in Poland, which in the first decade of transformation struggled with the problem of high level of structural unemployment (Śliwicki, 2013; Tatarczak & Boichuk, 2018). Then after accession to the European Union Poland experienced a wave of labour force exodus and currently starts to suffer from labour force shortages (Wachowska, 2018), which in the longer term can threaten high economic growth rate in the country and slow down the process of its economic convergence, and closing the development gap (Baran, 2013; Ricci, 2019). As a result, the main challenges of Polish labour market policy evolved from the issue of unemployment to the problem of the effective use of available manpower and the policies for labour activation or the objective of increasing level of employment (Bánociová & Martinková 2017; Rollnik-Sadowska & Dąbrowska, 2018; Gajdos & Arendt 2018; Lechman, 2019). This situation creates the needs for updating and building new diagnostic tools, which can be useful in researching the structural changes of the labour markets.

Within this context the research goal of the article is to present theoretical and historical background, which on the practical side enabled to build occupational labour model for Poland in the years 1995-2016. Therefore, the main empirical objective of this work is to conduct re-specification of the occupational model for major occupational groups with a high adjustment to empirical data, while maintaining high quality of statistical properties, which could be a useful tool for forecasting applications.

Therefore, the main novelty and value added of the current article should be mostly attributed to its applicability in providing guidelines for labour markets policy within next few years. To the best of our knowledge, the presented model is currently the most updated tool for research application with respect to the occupational structure in Polish labour market. However, the discussed approach should be not only limited to Poland, but it can be also of high value for both theoretical considerations and especially empirical guidelines with respect to econometric analyses of other Central and Eastern European labour markets, which are influenced by the same fundamental long term demographic and socio-economic factors as Polish economy.

The current contribution is structured as follow. The next part of the article presents literature review concerning theoretical basis and previous experience in the field of occupational structure modelling and forecasting in Europe, which was the source of the main guidelines for empirical part of the current contribution. As a result, the methodology developed by the CEDEFOP (European Center for the Development of Vocational Training), which is responsible for developing employment forecasts for all the EU Member States was discussed in details. Then, the specific national modelling experiences for Netherlands is discussed.

The Dutch model was a base for building the Czech model ROA-CERGE-EI, which was shortly discussed here. Against this background, the Polish methodology of modelling and forecasting the occupational structure of employees is finally presented.

It should be stressed here that the provided methodology was the first attempt in Poland to comprehensively forecast employment in the occupational cross-section perspective, which additionally translated into significant application achievements, allowing for the creation of a forecasting tool that enables interactive access to the forecasts developed.

In the next section the data bases from Statistics Poland, which were the source of the data for occupational cross-section analysis, were presented. Finally, in the last section the main empirical aim relating to the objectives of the article is obtained, where the re-specification of the model for the years 1995-2016 is given. The article ends with discussion, presentation of its limitations and final conclusions.

Modelling and forecasting the number of employees across occupations

Probably the most important experience in modelling and forecasting changes on national labour markets, also in the cross-section dimension, in recent years has been obtained by a project team operating at the EU institution CEDEFOP (European Center for the Development of Vocational Training). The team develops employment forecasts for all the European Union member states using analogous forecasting methods and comparable data sources (eg. Eurostat database or data derived from the Labour Force Survey – LFS). The CEDEFOP forecasting scheme for work demand consists of four basic modules: a set of macroeconomic forecasts in a multi-sector approach (module 1), a forecast model for new labour demand in an occupational approach (module 2), a forecast model for a new demand for labour in terms of across qualifications (module 3) and the forecasting model of the replacement demand for labour (module 4) (see Gajdos, 2016; Balcerzak, 2018). Therefore, the results published by this intuition are often considered as a good benchmark for specific national modelling based on current national data (see CEDEFOP, 2012). With this respect, the forecast provided by CEDEFOP were also used as a benchmark in the discussion section of the current article.

From the national perspective especially interesting experiences and methodological guidelines are provided by the Dutch ROA – *Research Centre for Education and the Labour Market,* which specialises in obtaining information on the future labour demand. The outcome of its work is used for better matching the labour market and education system in the Netherlands. Its work enables to move from employment forecasts according to occupations to the demand for labour by type of education, allowing to determine future changes in the qualification needs of the working population (Kwiatkowski *et al*., 2012, p. 59). This confirms the fundamental long term policy importance of the econometric research and applications of quantitative models for forecasting purposes, which can be helpful not only in current obtaining significant savings in terms of economic resources, but also diminish the risk of future negative shocks from labour markets, which would negatively influence social stability of the country.

The discussed forecasts are developed on the basis of a model explaining the occupational structure in the sectors of the Dutch economy for an average period of 5 years and they are updated every two years. The forecasting model is estimated with application of employment data in occupations and sectors coming from the Labour Force Survey (LFS) with relatively low data aggregation (the forecast for 2001-2006 was developed for 13 sectors of the economy, 104 types of education and 127 groups professional level consistent with the 3-digit level of the International Standard Classification of Occupations (ISCO)). In the forecasting process the data from the Ministry of Education on the school leavers are also used.

Forecasting of the demand for labour in the cross-section of occupations is based on the forecasts for total employment, which are used for developing a two-step model explaining the occupational structure within the sectors. At the same time, the assumption is made that the occupational structure of employment is determined by the demand side of the labour market. According to the scheme of the forecasting model, in the first step, employment changes by sectors are overestimated to changes in employment for a given occupational segment, and changes in the employment structure are estimated based on LFS data using a varying coefficients model. The size of a new demand for a given segment of occupations is disaggregated in order to determine the demand for particular occupational groups. The applied procedures enable to take into account the relationship between employment dynamics in individual occupations and in sectors, including short-term intra-sector dynamics, so the impact of changes in the sector's explanatory variables on employment in particular occupations in this sector and inter-sector dynamics, thus, the impact of changes in explanatory variables in a given sector for employment in individual occupations in other sectors (Kryńska (Ed.), 2011, pp. 36-38; Gajdos, 2016; see also Balcerzak, 2018;).

The discussed Dutch experiences were a benchmark for building another national model of employment forecasting for Czech Republic. The model ROA-CERGE-EI was proposed by CERGE–EI – *Centre for Economic Research and Graduate Education of Charles University in Prague.* The model enables to create employment forecasts by occupation and skills, which are prepared in a 5-year time horizon (with the aim of their updating every 2 years).

The first employment forecasts for 2000-2004 were based on forecasts of labour demand by sectors, for which the HERMIN model covering 4 main sectors of the economy (industry, services, agriculture and the non-service sector) was applied. Sectorial forecasts were used to generate forecasts in the cross-section of occupational groups and educational categories based on LFS data for the years 1993-1999. The obtained results enabled to disaggregate the sector's labour demand forecasts with respect to the creation of new jobs. Then, the forecast of the so-called replacement demand for work (labour) to the level of professional categories, as well as by educational categories were provided. In the case of the discussed model, the supply side of the labour market was also taken into consideration, while exogenous factors were not taken into account. In subsequent years, the ROA-CERGE-EI model was gradually modified and expanded, including in the area of examination of replacement demand for work (labour) or division of employment into categories. Additionally, some new auxiliary analysis tools (including inter-branch analysis, the labour market prospects index, or the payroll indicator) were also proposed (Kryńska (Ed), 2011, pp. 30-31; Gajdos, 2016; Gajdos & Arendt, 2014; Balcerzak, 2018).

In the case of Poland the methodology of modelling and forecasting the occupational structure of employees was developed during the implementation of Task 2. "*Development of an integrated forecasting and information system enabling forecasting of employment*" as part of the project entitled "*Analysis of the processes taking place on the Polish labour market and in the area of social integration in the context of economic policy*", which was implemented by the Human Resource Development Center in partnership with the Institute of Labour and Social Studies – IPiSS in 2009-2014 (with the authorship of Artur Gajdos, see Gajdos, 2016), as well as during the update of forecasts developed under the project, which was done for the Institute of Labour and Social Studies – IPiSS in 2015 (also realised by Artur Gajdos, see Gajdos, 2016). The discussed update in particular included the supply of the forecasting tool with new observations, making adjustments to employment forecasts by 2022, extending the econometric model of employment forecasts by occupations, and forecasting employment by occupational groups up to 2022 in various sections. It must be stressed here that the models and forecasts obtained as a result of implementation of this project constituted the first attempt in Poland to comprehensively forecast employment in the occupational cross-section. What is more, these results (also in detailed sections by medium occupational groups, sectors and voivodships) have been implemented in the Forecasting Tool (2019) (Gajdos & Arendt, 2014), which enables interactive access to prepared forecasts (see Gajdos, 2016). In the case of current article the following types of models were tested for the major occupational groups (Suchecki *et al*., 2013, pp., 164-165; Gajdos & Żmurkow-Poteralska, 2014):

1. Trend models of the number of employees and the share of employees (*t* - time variable):

$$LP\_X = f(t, \varepsilon_{Z0})$$

2. Causal models for the number of employees, where explanatory variable is total employment (*LP*) and time variable (*t*):

$$LP\_X = f(LP, t, \varepsilon_{Z0})$$

where:

X – number of the major occupational group (X = 0, ..., 9).

Though, it should be acknowledged that apart from the mentioned types of models, within the project the causal models of the number of employees were also tested, which included as an explaining variable the number of employees in the sector (sectors) dominating in a given occupational group; and deterministic models – transition tables for determining the occupational structure based on changes in the sectorial structure with modelling of sector shares in professional groups. However, these models were only pre-tested and were not used in further studies (see Gajdos & Żmurkow-Poteralska, 2012; Gajdos, 2014; Gajdos, 2016; Balcerzak, 2018).

The data sources for Poland and time series presentation

In line with current Polish experience in modelling and forecasting employment in the cross-section of occupational groups, the development of employment forecasts is done on the basis of Polish Statistics databases, which come mainly from two sources: statistical reporting and Labour Force Survey (LFS). With respect to the statistical reporting among the labour market data in the occupational cross-section one can find information on: registered unemployment, the number of vacancies, issued work permits and refusals to issue a permit for foreigners, professional activation of employees over 50 years old, remuneration. The second source Labour Force Survey (LFS) is representative, as it is carried out on a representative group of approximately 55,000 households, and since the fourth quarter of 1999 is conducted on a continuous basis. LFS is a source of information on: economic activity of the population, number of employed, unemployed and economically inactive. Data are published on a quarterly basis in the occupational cross-section, which is important from the point of view of the forecasts prepared.

Data published in a cross-section of occupational groups, both from the statistical reporting and from the LFS survey, are collected according to the Occupational Classification for the needs of the labour market, which is a five-level hierarchically systematized set of occupations and specialties. The classification structure, grouping individual occupations (specialties) into increasingly aggregated groups with specific symbols and names, enables conducting quantitative research at various levels of detail - starting from the basic ones, which are individual occupations and specialties, through , sub-major, minor and elementary occupational groups, up to the most general level (major occupational groups), which is presented in table 1.

Table 1. Classification of occupations and specialties and levels of qualifications

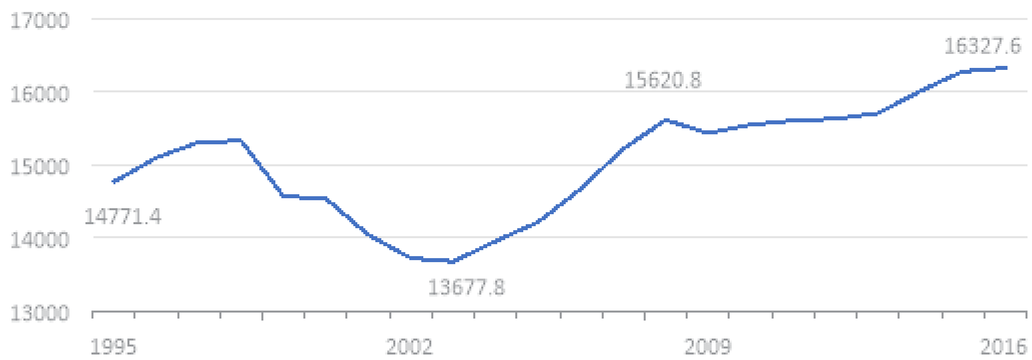
The name and code of the major group	**The number of groups within the major group**			**Number of occupations and specialties**	**The competence level based on ISCO-08**
	Sub-major	**Minor**	**Elementary**		
Managers (1)*	4	11	31	157	3 + 4
Professionals (2)	6	31	99	708	4
Technicians and Associate Professionals (3)	5	20	87	490	3
Clerical Support Workers (4)	4	8	27	68	2 + 3
Service and Sales Workers (5)	4	12	39	130	2 + 3

Skilled Agricultural, Forestry and Fishery Workers (6)	3	9	17	54	2
Craft and Related Trades Workers (7)	5	14	69	393	2
Plant and Machine Operators and Assemblers (8)	3	14	41	339	2
Elementary Occupations (9)	6	11	32	101	1
Armed Forces Occupations (0)	3	3	3	3	1,2 + 4
Together	**43**	**133**	**445**	**2443**	

Source: own work based on the Regulation of the Minister of Labour and Social Policy from 7 August 2014 on the classification of occupations and specialties for the needs of the labour market and the scope of its application (Dz.U. 2014 poz. 1145) (see also Balcerzak, 2018).

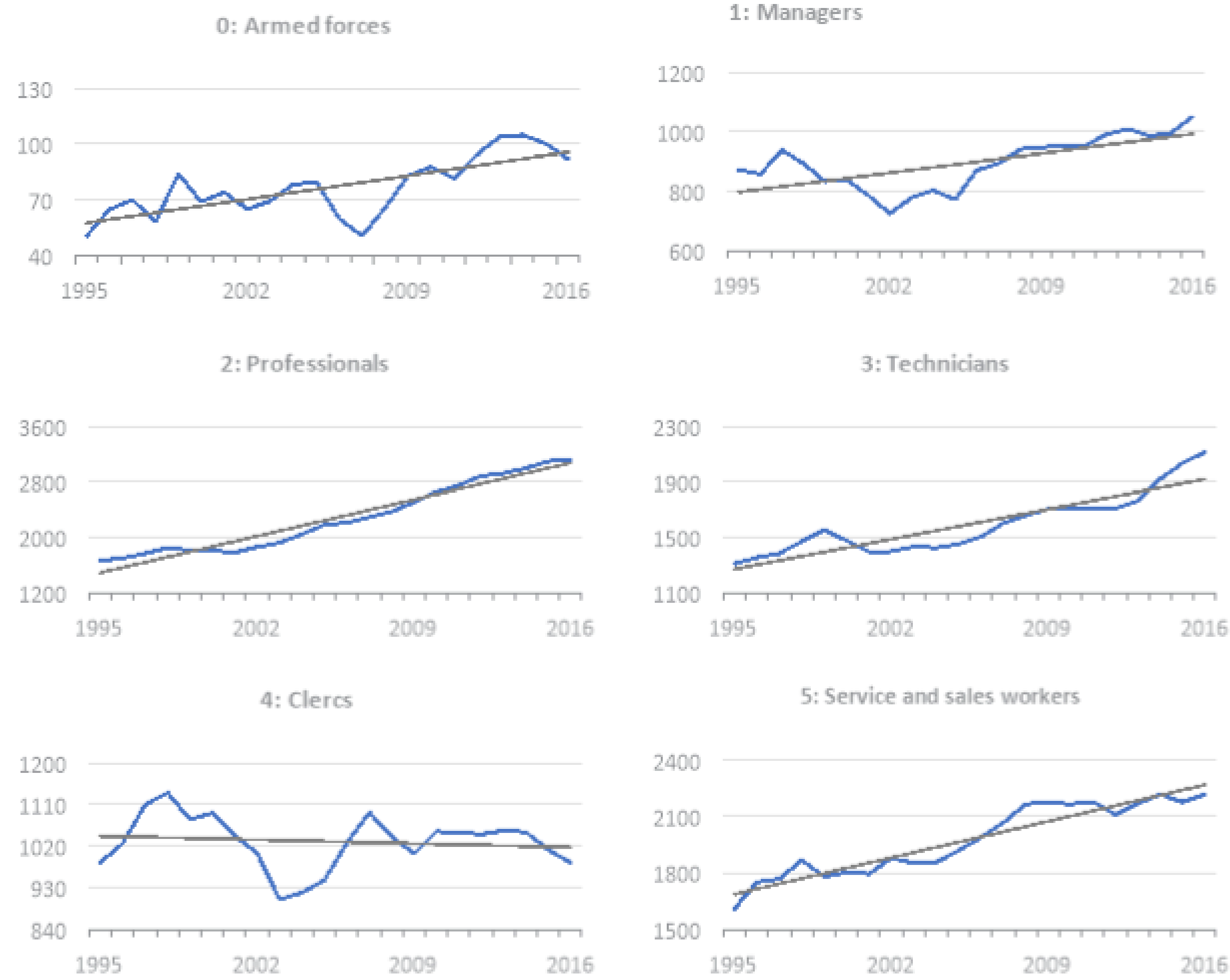
The specific time series on the total employment and employment across occupations groups from LFS survey, which were used in current research, are presented in figures 1 and 2. Figure 1 confirms the positive tendencies for Polish economy with a significant growth of the level of employment after the year 2003, which was only disrupted for a short time of the last global financial crisis. Additionally, data presented with figure 2 confirms the modernisation process of Polish economy with a long term positive trends in the number of employed for such groups as professionals, technicians or operators and assemblers and decrease in the number of employed for farm and related workers.

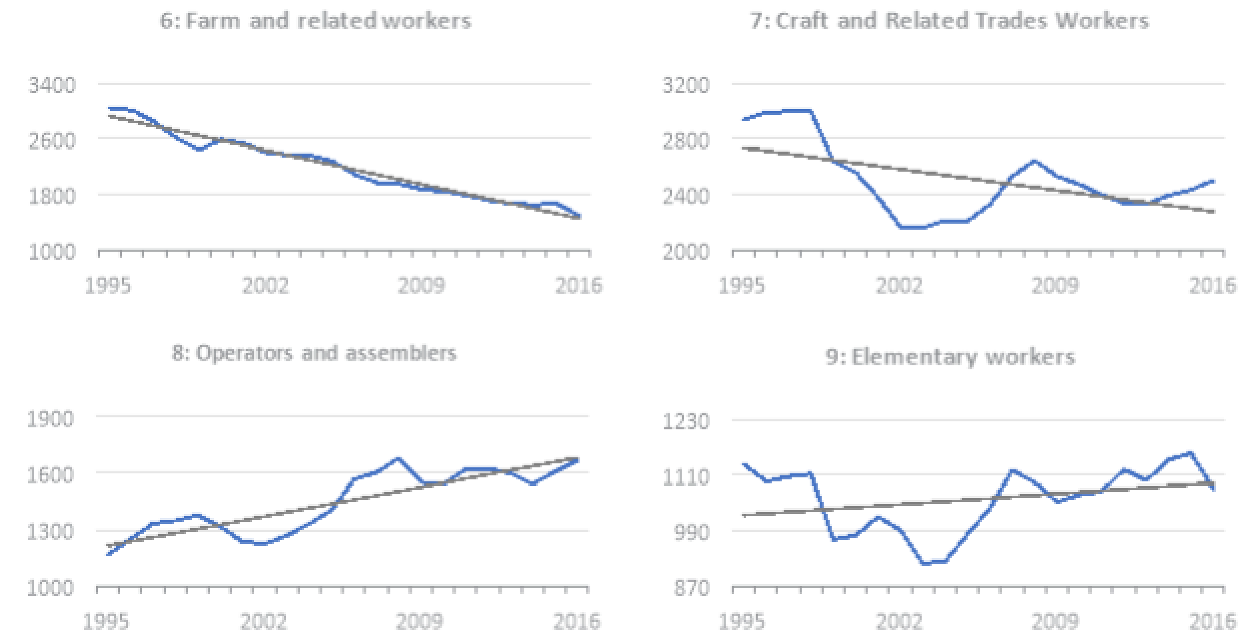
Figure 1. Total employment in Poland in the years 1995-2016 (in thousands of people)



Source: own work based on LFS.

Figure 2. Employment in major occupations groups in Poland in the years 1995-2016 (in thousands of people)





Source: own work based on LFS.

The model of changes in the number of employees in the cross-section of major occupational groups in the years 1995-2016: estimation results

The model for the years 1995-2016 was created to obtain a newer analytical tool of the number of people working in major occupational groups in Poland with better adjustment to empirical data, while maintaining high quality of statistical properties.

In order to re-specify the primary model (Gajdos, 2016), again the causal model was reselected. The total employment (LP) was assumed to be the explanatory variable and the development tendencies appearing were described with application of the appropriate form of time variable. According to the results of the trend analysis, each of the equations includes the occurrence of a potential type of trend, a linear trend, a non-linear trend or both trends at the same time. A natural logarithm for the time variable was used to model the variation of the nonlinear trend. During current re-specification of the model, a new set of dummy variables was used, the application of which allowed once again to obtain a better match with the empirical data and enabled to remove the autocorrelation of the random component. As a result, the model hypothesis of the re-specified occupational model has taken the form:

$LP\_Z0=\alpha 20*t+\alpha 50*LP_t+d950*d95+d990*d99+d06080*d0608+d070*d07+d13140*d1314+\varepsilon_{t0}$

$LP\_Z1=\alpha 21*t+\alpha 31*\ln t+\alpha 51*LP_t+d971*d97+d02051*d0205+d131*d13+\varepsilon_{t1}$

$LP\_Z2 = \alpha 22 * t + \alpha 32 * \ln t + \alpha 52 * LP_t + d07082 * d0708 + d122 * d12 + \varepsilon_{t2}$

$LP\_Z3 = \alpha 23 * t + \alpha 53 * LP_t + d993 * d99 + d05103 * d0510 + d11133 * d1113 + \varepsilon_{t3}$

$LP\_Z4 = \alpha 24 * t + \alpha 34 * \ln t + \alpha 54 * LP_t + d03054 * d0305 + d08094 * d0809 + d13144 * d1314 + \varepsilon_{t4}$

$LP\_Z5 = \alpha 35 * \ln t + \alpha 55 * LP_t + d08115 * d0811 + \varepsilon_{t5}$

$LP\_Z6 = \alpha 26 * t + \alpha 56 * LP_t + d986 * d98 + d01056 * d0105 + \varepsilon_{t6}$

$LP\_Z7 = \alpha 37 * \ln t + \alpha 57 * LP_t + d957 * d95 + d987 * d98 + d027 * d02 + d07097 * d0709 + d107 * d10 + \varepsilon_{t7}$

$LP\_Z8 = \alpha 38 * \ln t + \alpha 58 * LP_t + d01028 * d0102 + d06088 * d0608 + d11128 * d1112 + d148 * d14 + \varepsilon_{t8}$

$LP\_Z9 = \alpha 39 * \ln t + \alpha 59 * LP_t + d99009 * d9900 + d03049 * d0304 + d079 * d07 + d09109 * d0910 + d169 * d16 + \varepsilon_{t9}$

where:

LP_ZX_t – number of employed within major occupational group (X takes the numbers form 0 to 9 according to the codes of major occupational groups),

LP_t – the total employment,

t – time variable,

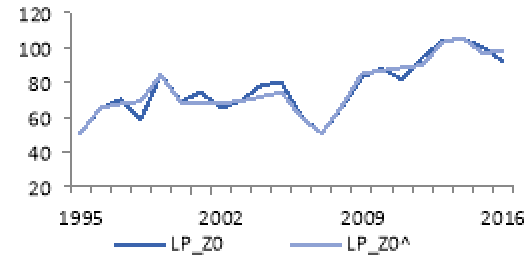
lnt – logarithm of time variable,

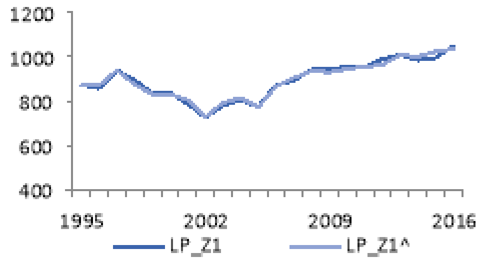
d – dummy variables,

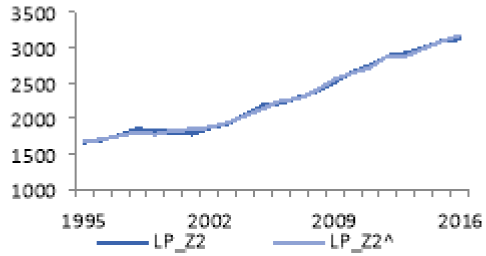
ε_{ti} – random term.

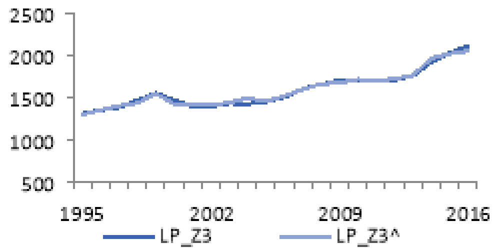
The classical least squares method was used to estimate the parameters of the occupational model. For the period 1995-2016, twenty-two observations were available. Presentation of the results obtained is done with a graphical form of the degree of matching the model theoretical values to the empirical values (Figure 3). In the case of the presented figures there is no situation, in which significant deviations in matching with empirical data would be visible. Estimates of the parameters with the statistical properties of the model are given in table 2.

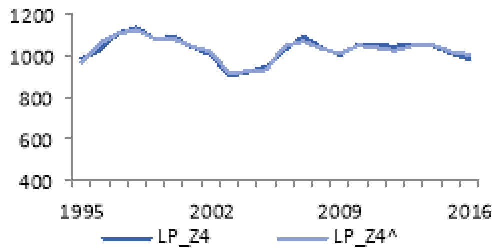
Figure 3. Adjustment of the theoretical values in major occupational groups to the empirical values in the re-specified occupational model

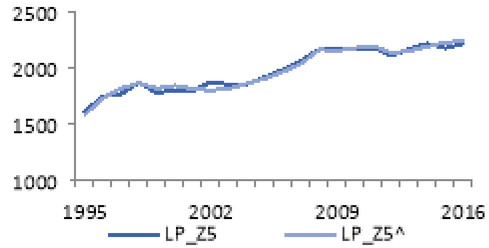

120
100
80
60
40
20
1995
2002
2009
2016
LP_Z0
LP_Z0^

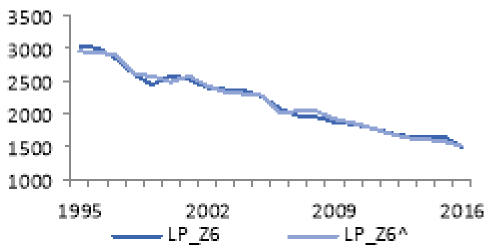

1200
1000
800
600
400
1995
2002
2009
2016
LP_Z1
LP_Z1^

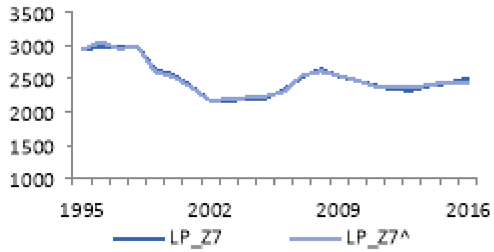

3500
3000
2500
2000
1500
1000
1995
2002
2009
2016
LP_Z2
LP_Z2^

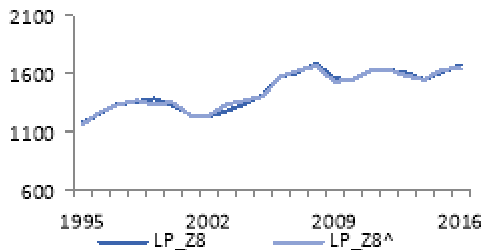

2500
2000
1500
1000
500
1995
2002
2009
2016
LP_Z3
LP_Z3^

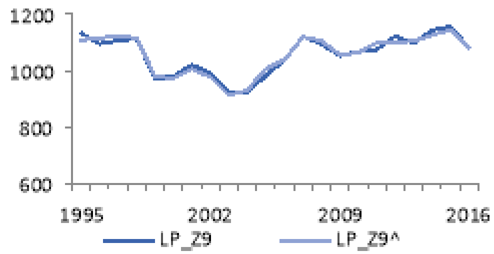

1200
1000
800
600
400
1995
2002
2009
2016
LP_Z4
LP_Z4^


2500
2000
1500
1000
1995
2002
2009
2016
LP_Z5
LP_Z5^


3500
3000
2500
2000
1500
1000
1995
2002
2009
2016
LP_Z6
LP_Z6^


3500
3000
2500
2000
1500
1000
1995
2002
2009
2016
LP_Z7
LP_Z7^


2100
1600
1100
600
1995
2002
2009
2016
LP_Z8
LP_Z8^


1200
1000
800
600
1995
2002
2009
2016
LP_Z9
LP_Z9^

Source: own estimation.

Table 2. Estimates of the parameters of the re-specified model of the number of employees in major occupational groups in the years 1995-2016

Equation	Variable*			Model fit R^2(adj)	Standard error
	t	ln*t*	LP_t		
LP_Z0	1.40 (0.000)*	-	0.004 (0.000)	0.904	4.99
LP_Z1	9.75 (0.000)	-42.88 (0.001)	0.06 (0.000)	0.970	15.32
LP_Z2	81.69 (0.000)	-125.63 (0.000)	0.11 (0.000)	0.995	35.47
LP_Z3	29.72 (0.000)	-	0.09 (0.000)	0.979	32.36
LP_Z4	-23.41 (0.001)	137.85 (0.002)	0.07 (0.000)	0.919	16.49
LP_Z5	-	158.19 (0.000)	0.11 (0.000)	0.969	33.63
LP_Z6	-83.93 (0.000)	-	0.21 (0.000)	0.979	66.35
LP_Z7	-	-367.45 (0.000)	0.22 (0.000)	0.982	35.66
LP_Z8	-	117.53 (0.000)	0.08 (0.000)	0.974	26.97
LP_Z9	-	-25.39 (0.000)	0.08 (0.000)	0.943	16.80

* The table does not include parameter estimates for dummy variables. ** The p-value values are given in brackets under the parameter evaluations.
Source: own estimation.

On the basis of the presented results, it is possible to provide an economic interpretation and statistical assessment of the quality of particular equations of the occupational model.

All the models are characterised with good statistical properties. The models are characterised with accepted adjustment to empirical data starting with very high level of adjustment at the level 99,5%, as it is in the case of 2nd major occupational group (professionals) to accepted level lowest level equal to 90,4%, as it can be found in the case of 0 occupational group (armed forces). In the case of all the models the increase in the total employment translates into an increase in the number of employees in a given major occupational group. The models for following major groups have a positive linear trend: armed forces (0), technicians (3); a positive linear and negative non-linear trend: managers (1), professionals(2); a positive non-linear trend: service and sales workers (5**),** operators and assemblers (8); a negative non-linear trend: craft and related trades workers (7), elementary workers (9); a negative linear and positive non-linear trend: clerks (4); a negative linear trend: farm and related workers (6).

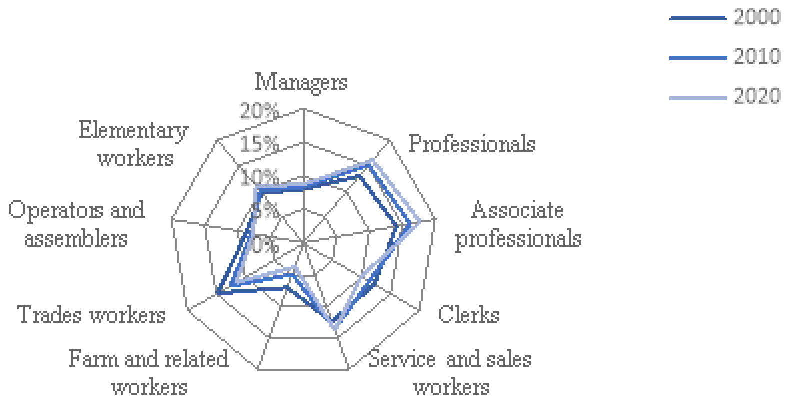
It can be concluded that as a result of the re-specification of the causal model for the major occupational groups a model with a high degree of fit to empirical data and correct statistical properties was obtained. This means that the specified occupational model should allow to obtain correct employment forecasts (see also Gajdos *et al*., 2017, Gajdos & Arendt, 2018).

Discussion and limitations

The conducted econometric research for the years 1995-2016 confirms the positive process of Polish economy modernisation and its structural adjustment to the requirements of highly competitive knowledge-based economy (see Balcerzak, 2015; Gajdos, 2016; Wierzbicka, 2018). Within this contexts one should point to positive tendencies with respect to the growth of employment for professionals or technicians, and decrease for clerks (office workers) and farm and related workers.

It is also worth to compare the obtained results at Polish national level to the projections make by CEDEFOP for all the EU-27 countries (see figure 4). In spite of the fact that the benchmarked forecasts were developed according to the old Classification of Occupations (ISCO-88), which significantly limits their comparative value with national forecasts, which from 2012 are performed according to the ISCO-08 standard, the tendencies observed in Poland for major occupational groups are still conducive to the ones, which are observed in the European countries.

Figure 4. CEDEFOP forecasts on the changes of the structure of employment for occupational groups in the EU-27 in the years 2000-2020 (in %)



Source: Gajdos (2016, p. 142).

However, the authors are aware that the presented research with the obtained results can be also subjected to critics and they are affected by important limitations, which must be pointed. The most important objective weakness of the current methodology is the lack of inclusion in the model of causal variables due to the unavailability of data for such variables with respect to major occupational groups. In a different class of models, for example industry-occupation models, it is possible with application of the symptomatic sectorial variables in relation to occupational groups (for example gross value added in the economic sector (agriculture, industry, services)).

Conclusions

The main purpose of the current article was to present the theoretical, historical and practical basis as well as the results of the re-estimation of the occupational model for Poland in 1995-2016. The carried out analysis consisted of two main parts. The first one was theoretical, its aim was to present the existing achievements in the field of modelling and professional forecasting at the European and national level. The second main part of the article was strictly empirical, where a re-specification of the occupational model was made. As a result of the re-specification of the causal model of the employment in major occupational groups, a model with a good fit to empirical data and correct statistical properties was obtained.

Form the labour market policy perspective the conducted research confirms the process of modernisation of Polish economy and its adjustment to the requirements of competitive knowledge-based economy. The research also confirms the structural changes that are conducive to the tendencies observed in the EU-27 countries.

With respect to the areas of future research, it can be expected that the occupational model that has been provided should have important application in forecasting and providing labour markets policy guidelines. The future research should also concentrate on the analysis of changes in the cross-section of sub-major and minor occupational groups, thus it should provide much more detailed analyses.

References

1. Balcerzak, A. P. (2015). Europe 2020 Strategy and Structural Diversity Between Old and New Member States. Application of Zero-unitarization Method for Dynamic Analysis in the Years 2004-2013. *Economics & Sociology*, 8(2), 190-210. https://doi.org/10.14254/2071-789X.2015/8-2/14.
2. Balcerzak, A. P. (2016). Technological Potential of European Economy. Proposition of Measurement with Application of Multiple Criteria Decision Analysis. *Montenegrin Journal of Economics*, 12(3), 7-17. https://doi.org/10.14254/1800-5845.2016/12-3/1.
3. Balcerzak, A. P. (2018). Reestymacja modelu zawodowego. Publikacja powstała w ramach projektu „System prognozowania polskiego rynku pracy" realizowanego przez Instytut Badań Strukturalnych, Wydział Ekonomiczno-Socjologiczny Uniwersytetu Łódzkiego oraz Instytut Pracy i Spraw Socjalnych. Warszawa: Instytut Pracy i Spraw Socjalnych, Wydział Ekonomiczno-socjologiczny Uniwersytet Łódzki, Instytutu Badań Strukturalnych.
4. Bánociová A., & Martinková S. (2017). Active Labour Market Policies of Selected European Countries and Their Competitiveness. *Journal of Competitiveness*, 9(3), 5-21. https://doi.org/10.7441/joc.2017.03.01.
5. Baran, K. A. (2013). The Determinants of Economic Growth in Hungary, Poland, Slovakia and the Czech Republic During the Years 1995-2010. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *8*(3), 7-26. https://doi.org/10.12775/EQUIL.2013.017.
6. Bieszk-Stolorz, B., & Markowicz, I. (2015). Influence of unemployment benefit on duration of registered unemployment spells. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *10*(3), 167-183. https://doi.org/10.12775/EQUIL.2015.031
7. CEDEFOP (2012). Future skills for supply and demand in Europe. Forecasts 2012. *Research paper,* No 26, Luxembourg: Publications Office of the European Union.
8. Forecasting Tool (2019). Retrieved form http://np.prognozowaniezatrudnienia.pl/ (15.05.2019).
9. Gajdos, A. (2016). *Struktura zawodowa rynku pracy w Polsce. Systemy informacyjne i prognozy.* Łódź: Wydawnictwo Uniwersytetu Łódzkiego.
10. Gajdos A., & Arendt Ł. (2018). Zmiany w strukturze zawodowej w Polsce do 2022 roku – czy rynek pracy podąża w kierunku polaryzacji. *Problemy Polityki Społecznej. Studia i Dyskusje*, 42(3), pp. 71-94.
11. Gajdos, A., Kusideł, E., & Grochowska, A. (2017). *Prognozy liczby pracujących w podregionach województwa mazowieckiego w przekroju sektorowym i zawodowym do 2022 roku*. Warszawa: Wojewódzki Urząd Pracy w Warszawie.
12. Gajdos, A., & Arendt, Ł. (2014). WWW.prognozowaniezatrudnienia.pl website and forecasting tool – an example of information and forecasting system. *Polityka Społeczna*, 2, pp. 38-46.

13. Gajdos, A., & Żmurkow-Poteralska, E. (2014). Employment forecasts by occupational groups in Poland. *Polityka Społeczna*, 2, pp. 14-20.
14. Gajdos, A. (2014). Spatial Analysis Of Human Capital Structures. *Comparative Economic Research. Central and Eastern Europe*, 17, pp. 43-54.
15. Gajdos, A., & Żmurkow-Poteralska, E. (2012). Skilled Personnel Supply and The Prospects for Regional Innovative Development in Poland. *Comparative Economic Research. Central and Eastern Europe*, 4, pp. 45-58.
16. Kopycińska, D., & Kryńska, E. (2016). The precariat in the labour market in Poland – social and economic aspects. *Journal of International Studies*, 9(2), pp. 79-89. https://doi.org/10.14254/2071-8330.2016/9-2/5.
17. Kryńska, E. (Ed.). (2011). *Prognozowanie zatrudnienia według zawodów – dorobek teoretyczny i wdrożeniowy – Świat i Polska.* Warszawa: IPiSS.
18. Kwiatkowski, E., Kwiatkowska, W., & Gajdos A., (2012). *Stworzenie koncepcji modeli prognoz zatrudnienia według zawodów dla wybranego województwa (Zadanie 1.8)*. Warszawa: IPiSS.
19. Lechman, E. (2019). Still 'few, slow and low'? On the female dimension of technology, labour markets and economic activity: Evidence for the period of 1990-2017. *Economics and Sociology*, 12(1), 11-38. https://doi.org/10.14254/2071-789X.2019/12-1/1.
20. Regulation of the Minister of Labour and Social Policy from 7 August 2014 on the classification of occupations and specialties for the needs of the labour market and the scope of its application (Dz.U. 2014 poz. 1145) [Rozporządzenie Ministra Pracy i Polityki Społecznej z dnia 7 sierpnia 2014 r. w sprawie klasyfikacji zawodów i specjalności na potrzeby rynku pracy oraz zakresu jej stosowania (Dz.U. 2014 poz. 1145)].
21. Ricci, A. (2019). Is There Social or Monetary Dumping in the European Union? Manufacturing Competitiveness in Central and Eastern Europe. *Entrepreneurial Business and Economics Review*, 7(1), 159-180. https://doi.org/10.15678/EBER.2019.070109.
22. Rolnik-Sadowska, E., & Dąbrowska, E. (2018). Cluster analysis of effectiveness of labour market policy in the European Union. *Oeconomia Copernicana*, *9*(1), 143-158. https://doi.org/10.24136/oc.2018.008
23. Śliwicki, D. (2013). Econometric Analysis of the Factors of Long-term Unemployment in Poland. *Oeconomia Copernicana*, *4*(2), 39-56. https://doi.org/10.12775/OeC.2013.012.
24. Suchecki, B., Gajdos, A., Lewandowska-Gwarda, K., Żmurkow-Poteralska, E. (2013) Prognoza wstępna zatrudnienia w kraju według grup zawodów. In *Prognoza zatrudnienia w Polsce według grup zawodów do 2020 roku*. Warszawa: IPiSS.
25. Tatarczak, A., & Boichuk, O. (2018). The multivariate techniques in evaluation of unemployment analysis of Polish regions. *Oeconomia Copernicana*, *9*(3), 361-380. https://doi.org/10.24136/oc.2018.018.
26. Wachowska, M. (2018). Consequences of the Post-Accession Migration of Polish Inventors for the Innovative Potential of Poland: 2004-2012. *Economics and Sociology*, 11(1), 311-324. doi:10.14254/2071-789X.2018/11-1/20.
27. Wierzbicka, W. (2018). Information infrastructure as a pillar of the knowledge-based economy — an analysis of regional differentiation in Poland. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *13*(1), 123-139. https://doi.org/10.24136/eq.2018.007.

Acknowledgments: *The current article is the result of realisation of the task "Re-estimation of occupational model" in the project "The System of Polish Labour Market Forecasting" which was financed under: Operational Program Knowledge Education Development, priority: II. Effective public policies for the labour market, economy and education, task: 2.4 Modernization of public and non-public employment services and their better adapting them to the needs of the labour market". The project was implemented by the Institute for Structural Research (leader), Faculty of Economics and Sociology at the University of Lodz and the Institute of Labor and Social Affairs.*