

THE ANALYSIS OF CHANCES OF YOUNG AND MIDDLE-AGED PEOPLE FOR HAVING A JOB USING BAYESIAN LOGISTIC REGRESSION MODEL¹

Wioletta Grzenda (ORCID: 0000-0002-2226-4563)
Collegium of Economic Analysis
Warsaw School of Economics, Poland
e-mail: wgrzend@sgh.waw.pl

Abstract: The aim of this article is to analyze the chances of having a job using Bayesian logistic regression model. In this study both young and middle-aged people have been considered. The individual characteristics of economically active people have a significant impact on their labour market status. In this research the commonly studied set of features has been extended by adding the following characteristics: marital status, financial situation of the household, health assessment and the fact of living with parents in the case of young people. In this study, Bayesian logistic regression model has been used. The Bayesian approach enabled us to incorporate information from previous studies.

Keywords: employment, logistic regression, Bayesian inference, MCMC

INTRODUCTION

The chances of having a job depend both on the macroeconomic situation, mainly concerning economic situation of the country, and the microeconomic situation in the local labour market. Notwithstanding the economic conditions, the individual characteristics of the economically active persons have a significant impact on the individuals' status on the labour market. Most frequently characteristics such as age, sex, education and place of living are considered in other studies e.g. [Bukowski 2011].

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Most research on the labour market suggests sex as the main determinant of employment. The situation of women in the labour market is often worse than men, which is reflected in a lower rate of economic activity and a higher level of unemployment among women. According to [CSO 2014] data, in the fourth quarter of 2014, in Poland the rate of economic activity for men was 64.7%, whereas for women 48.5%. In addition, the unemployment rate among women was higher than among men regardless of age. Only among people over 60, there was an inverse relationship. The issues relating to equal opportunities for women and men in the labour market are very complex and concern different aspects, namely economic, social and cultural. However, most studies show that men are more likely to have a job than women e.g. [Bieszk-Stolorz and Markowicz 2013].

Many studies emphasize the impact of education on the individual's situation on the labour market. With the increased share of university graduates among young people, the importance of higher education has been gradually decreasing since 2008. However, research shows that people with higher education are still most likely to find a job [Grzenda 2012]. It is worth noting that the level of education does not only affect the chances of finding work, but also has a significant impact on the stability of unemployment [Núñez and Livanos 2010]. In addition, the report [Ministry of Labour and Social Policy 2012] shows that the duration of unemployment decreases with rising levels of education.

The level of professional activity varies with age. Moreover, it is observed that the effects of determinants on professional activity differ depending on age. According to [CSO 2014] data, the highest unemployment rate is observed among persons aged 24 and under, whereas for the next age group 25-34 it is down by a half, which is still high compared to other age groups. High unemployment among young people is particularly worrying, because it limits their economic independence.

Polish labour market is highly diversified geographically as a consequence of uneven socio-economic development of different regions in Poland. The proportion of jobless people aged 25 and under in the total number of registered unemployed persons in 2012 ranged from 15% in dolnośląskie province to 23.3% in małopolskie province [Ministry of Labour and Social Policy 2012].

Having a job should be considered not only in terms of aspects referring to individuals, but also households they belong to. Moreover, combining work with family life is an important aspect of research in this area [Kotowska et al. 2007]. In this paper, the commonly studied set of features has been extended to include the following characteristics: marital status, financial situation of the household, health assessment and the fact of living with parents in the case of young people.

EMPIRICAL DATA

For the purpose of this study, a data set from the panel survey Generations and Gender Survey (GGS) for Poland conducted under the program Generations

and Gender Programme (GGP) has been used. The main objective of this international research program is to obtain information on demographic processes examined in the economic, social and cultural context [Kotowska and Jóźwiak 2011].

The data come from the second half of 2014. In addition, the missing information, which has not changed over time, has been supplemented based on the previous round of research carried out in the years 2010-2011. This study has been conducted among a random sample of respondents aged 18-79. The complete set of data has been divided into two age groups.

The first group included people aged 18-35 with 1960 observations. The second group consisted of people aged over 35 and under 55 with 2740 observations. The proportion of unemployed people among the young amounted to 19.39%, whereas for middle-aged people it was 11.82%. The results indicate a significantly worse situation of the young people on the labour market in Poland compared to the middle-aged people. According to the Labour Force Survey in the fourth quarter of 2015 [CSO 2016], the unemployment rate in Poland was 20.2% for people aged 15-24 and 7.8% for people aged 25-34.

The list of features used in the modelling is presented in Table 1. The initial set of features has been limited in the process of model building. Moreover, each of qualitative variables having k , $k \geq 2$ categories has been introduced into the models using $k - 1$ binary variables. Designations for the new variables have been adopted in accordance with the "Labels of levels" column (Table 1). The variable *marital status* has not been included in the model built for the young people, because it was strongly correlated with the variable *living with birth parents*. In addition, different variables have been used to assess the state of health of young and middle-aged people, due to insufficient numbers of observations in some levels of the variables.

Table 1. The list of characteristics of models

Variable	Names of levels	Labels of levels	Percent	
			Young people	Middle-aged people
Age group for middle-aged people	younger than 40	1		29.20
	older than 40 and younger than 44	2		23.03
	older than 44 and younger than 49	3	-	24.01
	49 years old and older	4		23.76
Age group for young people	younger than 24	1	29.08	
	older than 24 and younger than 29	2	27.81	-
	29 years old and older	3	43.11	
Sex	man	1	49.08	42.85
	woman	2	50.92	57.15

Variable	Names of levels	Labels of levels	Percent	
			Young people	Middle-aged people
Education status	higher	1	25.66	23.47
	post-secondary	2	17.50	11.72
	secondary professional	3	20.92	19.85
	secondary general	4	12.45	7.70
	basic vocational	5	15.66	31.09
	primary school	6	7.81	6.17
Marital status	unmarried, separated or divorced, a widower, a widow,	1	-	25.51
	married	2	-	74.49
Living with birth parents	no	0	54.29	-
	with at least one parent	1	45.71	-
Health problems	no	0	-	76.61
	yes	1	-	23.39
Health	very good	1	40.56	-
	good	2	49.49	-
	so-so and bad or very bad	3	9.95	-
Financial situation of household	poor or no response	1	20.97	25.18
	rather poor	2	25.51	27.04
	rather good	3	36.84	34.12
	good and very good	4	16.68	13.65
Region of Poland	central (łódzkie, mazowieckie)	1	16.68	16.02
	south (małopolskie, śląskie)	2	20.05	16.24
	east (lubelskie, podkarpackie, świętokrzyskie, podlaskie)	3	21.17	20.58
	northwest (wielkopolskie, zachodniopomorskie, lubuskie)	4	15.97	17.55
	southwest (dolnośląskie, opolskie)	5	10.71	14.05
	north (kujawsko-pomorskie, warmińsko-mazurskie, pomorskie)	6	15.41	15.55

Source: own analysis of the GGS data 2014

RESEARCH METHOD

The study examines a binary dependent variable describing the fact of having a job. A logit model often called logistic regression is used to model such variable [Finney 1972; Hosmer and Lemeshow 2000].

Let us consider an n -elements random sample and dichotomous dependent variable Y . Let $y_i = 1$ mean the occurrence of the test event, and $y_i = 0$ its non-occurrence, for $i = 1, \dots, n$. Moreover, let p_i be the probability of success i.e.

$y_i = 1$, $p_i = P(y_i = 1)$. Let $\mathbf{x}_i = [1, x_{i1}, \dots, x_{ik}]^T$ be a vector of independent variables, and $\boldsymbol{\beta} = [\beta_0, \beta_1, \dots, \beta_k]$ be a vector of regression coefficients.

The logit transformation is defined as follows:

$$\text{logit}(p_i) = \ln\left(\frac{p_i}{1-p_i}\right), \quad (1)$$

where:

$$\text{logit}(p_i) = \boldsymbol{\beta}\mathbf{x}_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_k x_{ki}. \quad (2)$$

In classical logistic regression model [Gruszczynski 2012] p_i is given by:

$$p_i = \frac{\exp(\boldsymbol{\beta}\mathbf{x}_i)}{1 + \exp(\boldsymbol{\beta}\mathbf{x}_i)}. \quad (3)$$

In this paper we consider the logistic regression model in Bayesian approach [Albert and Chib 1993; Gelman et al. 2000]. Statistical inference in the Bayesian approach is based on the posterior distribution. The posterior distributions are determined by the prior distributions and the likelihood function (Formula 5). The likelihood function for an n-elements random sample is:

$$L(\boldsymbol{\beta} | \mathbf{y}) = \prod_{i=1}^n [(p_i)^{y_i} (1-p_i)^{(1-y_i)}] = \prod_{i=1}^n \left[\left(\frac{\exp(\boldsymbol{\beta}\mathbf{x}_i)}{1 + \exp(\boldsymbol{\beta}\mathbf{x}_i)} \right)^{y_i} \left(1 - \frac{\exp(\boldsymbol{\beta}\mathbf{x}_i)}{1 + \exp(\boldsymbol{\beta}\mathbf{x}_i)} \right)^{(1-y_i)} \right] \quad (4)$$

Assuming normal prior distributions for the regression coefficients:

$$\beta_j \sim N(\mu_j, \sigma_j^2) \quad (5)$$

the posterior distribution is given by:

$$p(\boldsymbol{\beta} | \mathbf{X}, \mathbf{y}) \propto \prod_{i=1}^n \left[\left(\frac{\exp(\boldsymbol{\beta}\mathbf{x}_i)}{1 + \exp(\boldsymbol{\beta}\mathbf{x}_i)} \right)^{y_i} \left(1 - \frac{\exp(\boldsymbol{\beta}\mathbf{x}_i)}{1 + \exp(\boldsymbol{\beta}\mathbf{x}_i)} \right)^{(1-y_i)} \right] \cdot \prod_{j=0}^k \left[\frac{1}{\sqrt{2\pi}\sigma_j} \exp\left\{ -\frac{1}{2} \left(\frac{\beta_j - \mu_j}{\sigma_j} \right)^2 \right\} \right] \quad (6)$$

The Markov Chain Monte Carlo Methods (MCMC) [Casella and George 1992, Gelman et al. 2000] have been used to estimate model parameters. Examples

of the estimation of the models of qualitative variables using MCMC method can be found in the works [Marzec 2008a, b].

MODEL ESTIMATION

The estimations of all models have been performed using SAS system. Before administering the Bayesian modelling, potential explanatory variables have been selected and their significance and usefulness in explaining the phenomenon using classical methods verified.

The selection of the model and its evaluation in terms of its relevance for the observed data have been carried out using Akaike information criterion, Bayesian information criterion, deviance statistics and Pearson's chi-square test. The values of the last two of these statistics divided by the number of degrees of freedom have given 0.8987 and 0.9292 for the model for the young people, and 0.7269 and 1.0399 for the model for the middle-aged people. These results show that overdispersion has not occurred. The predictive power of the considered models has been also evaluated with 80% correct decisions predicted by the model. The second part of the modelling has been performed using the Bayesian approach. In Bayesian approach, the deviance information criterion (DIC) [Congdon 2006] has been used for the selection of the model.

In the first stage models have been estimated with the non-informative prior distributions, also referred as flat prior. Therefore, normal prior distributions with the mean 0 and variance 10^6 have been used for all regression parameters. Young people's situation on the labour market is the subject of many studies, so the model for the young people has been estimated with informative prior distributions based on the paper [Grzenda 2012]. However, for the examined data, the impact of prior distributions on posterior distributions has not been significant, due to large sample. The studies on the unemployment rate among middle-aged people are rarely found in the literature. Moreover, due to a large sample, this model has been estimated with non-informative prior distributions.

The estimated parameters for the young people model have been presented in the Table 2 (Model 1). The results for the middle-aged people model have been provided in the Table 3 (Model 2). Based on the highest probability density interval [Bolstad 2007], all variables for both models are statistically significant.

Table 2. Posterior sample mean and interval statistics

Model 1 for young people					
Parameter	Mean	Standard Deviation	Highest Probability Density Interval ($\alpha=0.05$)		Exp(Mean)
Intercept	1.7882	0.0110	1.7664	1.8089	5.9787
age_c1	-0.8342	0.00584	-0.8461	-0.8233	0.4342
age_c2	-0.5543	0.00489	-0.5636	-0.5445	0.5745
sex1	0.8991	0.00430	0.8911	0.9079	2.4574

Model 1 for young people					
Parameter	Mean	Standard Deviation	Highest Probability Density Interval ($\alpha=0.05$)		Exp(Mean)
education1	1.5181	0.00828	1.5027	1.5350	4.5635
education2	0.9823	0.00805	0.9672	0.9986	2.6706
education3	0.4246	0.00736	0.4101	0.4387	1.5290
education4	0.3025	0.00800	0.2874	0.3190	1.3532
education5	0.5164	0.00762	0.5016	0.5313	1.6760
living_parents1	-0.6320	0.00463	-0.6409	-0.6226	0.5315
health_Y2	-0.0448	0.00428	-0.0530	-0.0363	0.9562
health_Y3	-0.3242	0.00642	-0.3365	-0.3114	0.7231
financial_situation1	-1.4179	0.00684	-1.4308	-1.4039	0.2422
financial_situation2	-0.3080	0.00687	-0.3212	-0.2945	0.7349
financial_situation3	0.1033	0.00676	0.0904	0.1170	1.1088
region1	-0.1021	0.00650	-0.1153	-0.0898	0.9029
region2	0.1521	0.00664	0.1392	0.1650	1.1643
region3	-0.5213	0.00683	-0.5346	-0.5078	0.5937
region4	0.1827	0.00736	0.1687	0.1972	1.2005
region5	-0.2869	0.00786	-0.3025	-0.2720	0.7506

Source: own analysis of the GGS data 2014

Table 3. Posterior sample mean and interval statistics

Model 2 for middle-aged people					
Parameter	Mean	Standard Deviation	Highest Probability Density Interval ($\alpha=0.05$)		Exp(Mean)
Intercept	2.2612	0.0131	2.2342	2.2866	9.5946
age_c1	0.1083	0.0054	0.0980	0.1191	1.1144
age_c2	0.4786	0.0063	0.4664	0.4913	1.6138
age_c3	0.1246	0.0056	0.1140	0.1357	1.1327
sex1	0.6811	0.0043	0.6723	0.6892	1.9761
education1	1.8378	0.0088	1.8210	1.8550	6.2827
education2	1.4598	0.0094	1.4418	1.4785	4.3051
education3	1.2977	0.0079	1.2823	1.3134	3.6609
education4	0.8008	0.0091	0.7830	0.8186	2.2273
education5	0.4044	0.0068	0.3910	0.4175	1.4984
marital1	-0.6000	0.0042	-0.6079	-0.5914	0.5488
health_problems1	-0.1438	0.0046	-0.1531	-0.1349	0.8661
financial_situation1	-2.0734	0.0103	-2.0936	-2.0534	0.1258
financial_situation2	-1.0506	0.0106	-1.0698	-1.0282	0.3497
financial_situation3	-0.3382	0.0109	-0.3596	-0.3168	0.7131
region1	-0.2327	0.0070	-0.2464	-0.2196	0.7924
region2	0.3157	0.00780	0.3010	0.3313	1.3712
region3	-0.6958	0.00701	-0.7100	-0.6825	0.4987
region4	0.0387	0.00736	0.0245	0.0535	1.0395
region5	0.0247	0.00803	0.00980	0.0410	1.0250

Source: own analysis of the GGS data 2014

Geweke test has been used to assess the convergence of Markov chains. This test is based on comparing the mean value for the first part of the chain and the mean value for the last part of the chain. Based on the results for the first model (Table 4) it has been found that there is no indication that Markov chains have converged, at the level of significance $\alpha=0.05$, for all the parameters of the model.

For the second model, for 2000 burn-in iterations, the convergence of all chains has not been identified, therefore, the burn-in number has been increased to 4000. Then, for the level of significance $\alpha=0.05$, it has been asserted that there are no grounds to reject the verified hypothesis of convergence of chains. Moreover, Monte Carlo standard errors (MCSE) have been given in Table 4 for all investigated parameters.

Table 4. Geweke convergence diagnostics and MCSE

Parameter	Model 1 for young people			Model 2 for middle-aged people		
	Geweke diagnostics		MCSE	Geweke diagnostics		MCSE
	z	p-value		z	p-value	
Intercept	0.0160	0.9872	0.00069	1.1152	0.2648	0.00095
age_c1	-0.1086	0.9135	0.00016	-0.3681	0.7128	0.00011
age_c2	-0.0728	0.9420	0.00011	-0.2163	0.8288	0.00011
age_c3	-	-	-	-0.0254	0.9797	0.00011
sex1	-0.1207	0.9039	0.00009	0.1076	0.9143	0.00006
education1	-0.0702	0.9440	0.00036	-0.0530	0.9578	0.00028
education2	-1.2906	0.1968	0.00033	0.2847	0.7759	0.00028
education3	-0.2668	0.7897	0.00030	0.0544	0.9566	0.00028
education4	0.0422	0.9664	0.00031	-0.2790	0.7803	0.00028
education5	-0.1460	0.8839	0.00028	0.3230	0.7467	0.00026
living_parents1	-0.1572	0.8751	0.00010	-	-	-
marital1	-	-	-	-1.4990	0.1339	0.00007
health_Y2	-0.3614	0.7178	0.00009	-	-	-
health_Y3	-0.3313	0.7404	0.00011	-	-	-
health_problems1	-	-	-	-0.7781	0.4365	0.00007
financial_situation1	-0.1326	0.8945	0.00031	-1.3700	0.1707	0.00068
financial_situation2	0.0432	0.9656	0.00027	-1.4842	0.1377	0.00068
financial_situation3	-0.4101	0.6817	0.00026	-1.4668	0.1424	0.00066
region1	-0.0630	0.9498	0.00020	0.2659	0.7903	0.00021
region2	0.0160	0.9872	0.00020	-0.4396	0.6602	0.00021
region3	-0.1086	0.9135	0.00020	-0.4891	0.6247	0.00021
region4	-0.0728	0.9420	0.00021	-0.2203	0.8256	0.00021
region5	-0.1207	0.9039	0.00021	0.0805	0.9358	0.00021

Source: own analysis of the GGS data 2014

SUMMARY AND CONCLUSION

This study provided insights into the impact of selected characteristics on the chances of having a job among young and middle-aged people.

For the interpretation of results of the estimated models odds ratio has been used. The odds ratio is the value of $\exp(\hat{\beta}_j)$, $j = 1, \dots, k$ where $\hat{\beta}_j$ is the estimate of model parameter [Gruszczyński 2012]. The values of $\exp(\hat{\beta}_j)$ have been presented in the Table 2 and 3.

While examining the characteristic *age* for the first model it has been shown that people under the age of 24 have about 56.58% less chance of having a job than those over 29. Moreover, people aged 24-29 have about 42.55% less chance of having a job than people in the oldest group. In the second model it has been indicated that the oldest age group i.e. people aged 49 and older have the lowest chance of having a job. Finally, people aged 40-44 have about 61.38% higher chance of having a job compared to the oldest group.

Some earlier assumptions that men have higher chance of having a job than women have been confirmed. For young people it has been shown that men have about 145.74% higher chance of having a job than women, whereas for the middle-aged people it is 97.61%.

Education is another important determinant widely discussed in various studies. People with primary education have the lowest chance of having a job among young people. People with higher education have about 356.35% higher chance to be employed than people with primary education and people with secondary professional education have about 167.06% higher chance of having a job than people with primary education. Other levels of education result in approximately 35%-53% increase in the chance of having a job compared to the lowest level of education. In the case of older people, these differences are even greater with the exception of professional education for which a similar value has been obtained. However, for higher, post-secondary and secondary professional education in this age group there seem to be 200% bigger odds of having a job for each level of education compared to the results obtained for young people.

Young people living with their parents have about 46.85% less chance of having a job than people who do not live with their parents. Single people in their middle age have about 45.12% less chance of having a job than people who are in a relationship.

Considering the self-assessment of health, it can be concluded that in the case of young people health situation has little effect on the chance of having a job. Those assessing their health as so-so and bad or very bad have about 27.69% less chance of having a job than people who evaluate their health as very good. Similarly, among the middle-aged, people with health problems have about 13.39% less chance of having a job than people who do not have any health problems.

The financial situation of the respondent's household was another investigated characteristic. For the young people it has been indicated that people who evaluated the financial situation of their household as poor or did not answer this question have about 75.78% less chance of having a job than people who evaluated their material situation as good and very good. Those who assessed the situation of their household as rather poor have about 26.51% less chance of having a job, while people who evaluated the situation of their household as rather good have about 10.88% higher chance of having a job than people who admitted that the situation of their household is good and very good. For the middle-aged people similar results have been obtained, except for the level: rather good. People who evaluated the financial situation of the household they belong to as less than good and very good have less chance of having a job. People who described the financial situation of their household as rather good have about 28.69% less chance of having a job than people who evaluated their financial situation as good and very good.

For the characteristics *region* the results are similar both for the young and middle-aged people. Compared to the northern region, young people in the southern region have 16.43% higher chance of having a job and about 20% higher in the northwest region. At the same time middle-aged people have 37.12% higher chance of having a job in the southern region than in the northern region; the figures for the northwest and southwest region are 3.95% and 2.5% respectively. In contrast, people who live in the eastern region have the least chance of having a job, irrespective of their age.

In this paper the impact of selected determinants on the chance of having a job has been considered. This research has provided a comparative analysis of the situation of young and middle-aged people on the labour market. The analysis of two most important determinants of activity: sex and education has indicated that gender has much greater effect on the chance of having a job for young people than for middle-aged people. As for education, the figures suggest that higher and post-secondary education have much greater impact on the chance of having a job for middle-aged people, than for young people. By identifying differences in the effects of selected determinants on the odds of having a job among young and middle-aged people this paper has expanded the results of previous studies on the reasons of high unemployment among young people.

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