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ANALYSIS OF JOB CHANGES IN POLAND USING THE BAYESIAN METHOD

Abstract: The primary objective of the work is to identify demographic and socio-economic factors influencing occupational mobility in Poland in the years 1950–1988. The career mobility has been modelled using a Bayesian Poisson regression model. Analysis of employment periods has been performed for three age groups. Moreover, in spite of the small size of the third age group, the Bayesian approach enabled result comparison for all age groups. In modelling the number of employment periods, the following determinants have been considered: the place of residence, sex, education level, the intention to continue education within two years, the intention to change place of residence within two years, having a family, the number of children, socio-occupational group and the age of entering workforce.

Key words: occupational mobility, job changes, state socialism, Poisson regression model, Bayesian method.

1. Introduction

Employees in Poland prefer stability of employment, willingness to change job is expressed by only 15% of them, while 84% of employees are not planning to find a new employer and 69% are totally sure they are not going to search for a new employer (Public Opinion Research Centre, 2006). This situation might have been caused by the labour market organization before 1989. State-socialist work structures before economic transformation did not promote frequent job changes. The dominance of the public sector and state-controlled, regulated economy resulted in limited motivation for career mobility, as most of the work and payment conditions were defined centrally and the range of choices was largely constrained [Kryńska (Ed.) 2001].

At the same time, the comparative study of career mobility in the Federal Republic of Germany and Poland has shown that the frequency of job changes in Poland was higher in the analyzed period, which contradicts stereotypes about limited employee mobility in state-socialist societies [Mach et al. 1994]. Taking into account the lack of detailed studies regarding job changes in Poland during the regulative

economy period (1950–1989) [Jezierski, Leszczyńska 2001], research on career mobility and the most important factors affecting it should be continued.

The retrospective survey "Polish Family and Fertility Survey"[1] performed in 1991 shows that almost 50% of respondents changed job at least once. According to the same survey, the most frequent reasons for starting work or changing jobs were that adult workers felt obliged to be employed for financial and family reasons and they wanted to maintain and improve their standard of living, the less important factors were personal development and the need for improving qualifications. At the same time the job changes might have been affected by many other demographic and socio-economic factors. Among them age, sex, education level, place of living, having a family, number of children and socio-occupational group could be considered.

The primary objective of the work is to identify key factors influencing career mobility in Poland in the years 1950–1988 and estimate their impact on it by using the Bayesian Poisson regression model. In this work, career mobility is expressed by the number of employment periods, except for career breaks caused by maternity leave or long-term illness.

A discussion on different forms of employee mobility during the transformation period can be found in [Kryńska (Ed.) 2000]. The work concentrates on the description and analysis of work resources on regional labour markets in Poland and aims to recommend how mobility could be increased and stimulated. Mobility analysis, both at intra- and inter-organization level, has considered the following demographic and professional features: age, sex, place of residence, education and employment status. In addition, other determinants including travel time to work, income and work experience have been included. The methods applied in the work rely on the comparison of percentage shares. Contrary to this approach, in our work a statistical model has been applied. This allows the investigation of the joint impact of selected determinants on career mobility.

The analysis of three forms of employee mobility, i.e., career mobility, inter-organizational mobility and the spatial mobility of graduates employed in the public sector on the territory of three regions has been described in [Witkowski 1983]. The study began in 1977 in the Bielsk Podlaski region. It continued in 1978–1979 in the Olsztyn and Warsaw regions. Different combinations of mobility forms in terms of their frequency have been investigated. Moreover, for each of the regions and each mobility form the impact of demographic, socio-environmental and professional factors using a classical regression model has been analyzed. The main motivation for this research was to identify employee attributes that have a substantial influence on career mobility in different subpopulations of highly educated employees. The question may be asked, what features influenced the career mobility of the remaining part

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[1] Research performed by the Institute of Statistics and Demography of the Warsaw School of Economics and Central Statistical Office in 1991, as a part of European program "Family and Fertility Survey" coordinated by the Population Activity Unit Commission for Europe, UN, Geneva.

of Polish society in the period of the state-socialism economy, as highly educated persons were only 2.7% of Polish society during this period (Census data, 1970).

The comparison of career mobility conceived as a sequence of job-shifts within and between organizations in Poland and the Federal Republic of Germany has been performed by W. Mach, K.U. Mayer and M. Pohoski (1994). In the case of Poland the survey data collected in 1972 for persons born in the period 1939–1941 has been used. The following determinants of employee mobility have been taken into account: sex, education, occupational experience, social class, firm size and industrial sector. The authors emphasize that Polish enterprises of this period, in spite of strict control through central planning and state-monopolized supply of capital, had to compete for labour power in the labour-market. The labour market was well developed and to a great extent free from any form of administrative control over the allocation of labour. At the same time, the analysis reveals significant differences in the dynamics of job changes and the scale of impact of individual factors between Poland and the Federal Republic of Germany.

The largest employee mobility in the analyzed period was observed in the USA. The research on the career mobility of men shows the significance of education [Sicherman, Galor 1990]. The employees with higher education status were found to have a lower number of distinct professions and therefore were less likely to change jobs and employers. Moreover, the research shows that career mobility is reduced with more work experience. The fact that intra-organization job mobility is controlled by employers, while inter-organization changes are largely decided upon by the employees, has been emphasized. Still, both mobility forms are affected by many other factors. The identification and investigation of these factors is the objective of this work.

2. The scope of the analysis

The study has been based on the retrospective research "Polish Family and Fertility Survey". Our work includes all the persons who were employed at least once, except for self-employed farmers, for whom their family farms were the main source of income. The analysis takes into account the whole employment periods of the respondents during the period 1950 till 1988.

In order to consider the fact that different factors may influence job changes for young persons starting their professional careers and for more experienced employees, three groups have been investigated separately: the persons aged 18–30 years (1654 observations), 31–45 years (2779 observations) and 46 or more years (269 observations).[2] The last group has the lowest number of observations. However, it contains the most data regarding professional career as older employees are more

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[2] In the remainder of the work the age groups 18–30 years, 31–45 years and 46 or more years will be called the first age group, the second and the third age group, respectively.

reluctant to change jobs. These groups have been set up in accordance with the changes in observed employment rates for different age groups [Drobnič, Frątczak 2001] and age-related tendencies in career mobility [Kryńska (Ed.) 2000].

The analysis of career mobility has been performed using a Bayesian generalized linear model. Because dependent variable is the number of employment periods (min. = 0, max = 10), a Bayesian Poisson regression model has been applied. The proposed model enables the investigation of the joint influence of different factors on the number of employment periods. An important advantage of Bayesian analysis is the ability to produce reliable conclusions even in cases of a limited number of observations, as in the case of the third age group.

3. Research hypotheses and variables

Considering the aforementioned diversity of opinions, expressed in different studies devoted to career mobility during the state-socialism period in Poland, the primary objective of the work is the investigation of dependencies between career mobility defined as the number of employment periods and the demographic and socio-economic factors. The research hypotheses, and the characteristics of independent variables which potentially have an impact on career mobility have been discussed below.

After the Second World War, a reconstruction and an accelerated process of industrialization led to high labour demand especially in towns. Hence, one can expect that higher mobility should be observed for respondents living in big cities rather than those living in villages, as it is easier to find a job in bigger cities. When we consider the place of residence we have to take into account the intensive migration from rural to urban areas which took place in the period 1950–1989. Until 1980 an ever growing migration balance to the urban areas was observed. The economic crises of the eighties resulted in a substantial reduction of spatial mobility [Kotowska (Ed.) 1999]. Having considered these factors, the first variable is the place of residence at the moment of examination; the values of this variable are: 1 = a big city – above 200,000 residents (32.52%), 2 = a small city (37.75%), 3 = a village (29.73%).

Finding a job or a willingness to change it may require changing place of residence. Thus the persons considering the latter change should have higher career mobility rates too. The intention to change place of residence within the next two years is the next variable to consider. As in the previous case the interpretation of its values is as follows: 1 = yes or I am in the process of changing my place of residence (6.47%), 2 = I do not know (8.02%), 3 = no (85.52%).

The labour market before the transformation period in Poland was characterized by the high participation of women in the workforce. Economic necessity, the ideology of equal rights of women and full employment policy contributed to the rapid

growth of occupational activity of women [Frątczak 1999]. Having considered the traditional family model, one can expect that higher mobility should be observed for men rather than for women. Another determinant which has been taken into consideration is sex: 0 = woman (42.32%), 1 = man (57.68%).

The increase in education attainment of the generations in Poland after the Second World War has been striking. The proportions of persons having a secondary level and tertiary level education have sharply risen [Drobnič, Frątczak 2001]. What should be emphasized, however, is that graduation did not always mean promotion or a higher salary. In fact, in some cases university graduates earned less than individuals with basic vocational training. Nevertheless, we can suppose that education is one of the most important factors influencing the chance to find and keep a job, moreover a higher level of education should result in increased chances for an occupational promotion. Education variable takes the following values 1 = higher (10.91%), 2 = post-secondary (5.19%), 3 = secondary professional (22.97%), 4 = secondary general (8.32%), 5 = basic vocational (38.09%), 6 = primary school (14.53%).

In order to investigate whether the respondents who continue education have higher mobility rates, the intention to continue education within the next two years has been included. The variable takes the following values: 1 = yes or I am studying at the moment (5.74%), 2 = I do not know (5.66%), 3 = no (88.6%).

Poland in the state-socialism period was characterized by a relatively high fertility rate and occupational activity. Both positive [Brewster, Rindfuss 2000] and negative [Hilgeman, Butts 2009] relationship between a rise in the number of women active in the labour market and fertility has been observed. Furthermore, on the one hand the persons having their own families and/or children can be more likely to change jobs, as they want to improve the standard of living. On the other hand, the responsibility for their families may cause the anxiety to change jobs. Thus, having a family has been selected as the next variable to consider with the following interpretation of answers 0 = no (13.76%), 1 = yes (86.24%). Consequently, the number of children has been added as one more variable, with four categories used: 0 (19.37%), 1 (23.76%), 2 (38.54%), 3 or more (18.33%).

Polish enterprises depended on central economic administration for investment and financial resources, pricing, and employment regulations. In the state-socialism period particular attention was paid to the industrial sector. Moreover it was not the state administration and public service, but mining and steel industries that were privileged in job-shift patterns [Mach et al. 1994]. Therefore frequency of job changes might be also dependent on the sector. Thus, the socio-occupational group a respondent belonged to at the moment of entering the workforce has been added. The following classes have been identified 5 = factory workers and similar professions (25.41%), 4 = employees of transport, trade and services (19.33%), 3 = experts in engineering and non-engineering professions (19.54%), 2 = clerks (15.33%), 1 = remaining employees (20.37%).

Finally, one can assume that persons who start their professional careers earlier change jobs more frequently before they reach stability. Therefore, the age of entering workforce has been added too. The minimal age was 15 years; the maximal value reported in the survey was 43 years.

4. The method

In this paper we have used a Bayesian Poisson regression model; the advantages of using Bayesian methods can be found in [Bolstad 2007; Gelman et al. 2000]. The Bayesian analysis of Poisson regression models has been discussed in many works [Dey et al. 2000; El-Sayyad 1973].

Let variable y_i, $i = 1, 2, ..., n$ have Poisson distribution with mean λ_i. If a link function is logarithm, then $\ln(\lambda_i) = \sum_{j=1}^{k} x_{ij}\beta_j$, where x_{ij} are independent variables, $\boldsymbol{\beta} = (\beta_1, ..., \beta_k)$ is a vector of unknown parameters. Therefore $\lambda_i = \exp\left(\sum_{j=1}^{k} x_{ij}\beta_j\right)$. Then the likelihood function of parameters vector $\boldsymbol{\beta}$ is given by

$$L(\boldsymbol{\beta};\mathbf{y}) = \left(\prod_{i=1}^{n} y_i!\right)^{-1} \exp\left(-\sum_{i=1}^{n}\exp\left(\sum_{j=1}^{k} x_{ij}\beta_j\right) + \sum_{j=1}^{k}\beta_j\sum_{i=1}^{n} x_{ij}y_i\right).$$

Examples of prior distributions for parameters of generalized linear models can be found in [Dey et al. 2000]. In Bayesian inference special role is played by non-informative priors, which have a minimal impact on a posterior distribution. Sometimes distributions which are sufficiently non-informative can be used. In the case of a normal distribution we use zero mean and any large number for variance. For parameters $\beta_1, ..., \beta_k$ we take the normal prior distributions with mean m_j and variance σ_j^2, the joint density of $\beta_1, ..., \beta_k$ is given by

$$p(\beta_1,...,\beta_k) = \prod_{j=1}^{k} \frac{1}{\sigma_j\sqrt{2\pi}}\exp\left(-\frac{1}{2\sigma_j^2}(\beta_j - m_j)^2\right).$$

Therefore, the posterior distribution can be written in a closed form, up to a constant proportionality

$$p(\beta_1,...,\beta_k \mid \mathbf{y}) \propto \exp\left(-\sum_{j=1}^{k}\frac{1}{2\sigma_j^2}\beta_j^2 + \sum_{j=1}^{k}\left(\frac{m_j}{\sigma_j^2} + \sum_{i=1}^{n} x_{ij}y_i\right)\beta_j - \sum_{i=1}^{n}\exp\left(\sum_{j=1}^{k} x_{ij}\beta_j\right)\right).$$

Only in the simplest examples the marginal posterior distribution can be obtained analytically, usually we use a simulation method for sampling from posterior distribution – Markov chain Monte Carlo (MCMC). A Gibbs sampler [Casella, George 1992] is a special case of the Metropolis-Hastings sampler, it has been used to obtain a sample from the posterior distribution in this paper.

5. The estimation of models

The estimation and verification of all the models has been performed using the SAS system. Taking into account the characteristics of the variable and preliminary simulations, in the case of the third age group, the following variables have been skipped: the intention to continue education within the next two years, the intention to change place of residence within the next two years and having a family. The two remaining models include all the variables listed in the introduction of the work.

In order to obtain objectively correct results, we have used non-informative independent normal prior distributions for all regression parameters to estimate all the models: $p(\boldsymbol{\beta}) \sim N(\mathbf{0}, 10^6\,\mathbf{I})$.

Inference in Bayesian analysis under unchecked convergence may result in wrong conclusions. Using Geweke's test [Geweke 1992] we have found that there is

Table 1. Exponent of posterior sample mean

Parameter	The age groups		
	18–30 years	31–45 years	Above 45 years
Intercept	2.898*	2.723*	3.731*
The age of entering workforce	0.866*	0.904*	0.894*
The place of residence 1	1.507*	1.206*	1.200
The place of residence 2	1.143	1.123*	1.346
Sex	2.203*	1.723*	1.622*
Education 1	1.060	1.434*	1.986*
Education 2	1.418	1.164	1.595
Education 3	1.162	1.186*	1.480
Education 4	1.064	1.016	1.312
Education 5	1.109	0.897	0.832
The intention to continue education 1	0.872	0.986	–
The intention to continue education 2	0.911	1.026	–
The intention to change place of residence 1	0.775	1.032	–
The intention to change place of residence 2	0.859	0.982	–
Having a family 0	1.083	1.265	–
The number of children 0	0.452*	0.937	1.500
The number of children 1	0.754*	1.000	0.968
The number of children 2	0.973	0.960	0.755
The socio-occupational group 1	1.510*	1.462*	1.408
The socio-occupational group 2	1.417	1.277*	1.451
The socio-occupational group 3	1.277	1.052	1.352
The socio-occupational group 4	1.373*	1.253*	1.313

* significant, $\alpha = 0.05$.

Source: own study.

no indication that the Markov chain has not converged for all the parameters of investigated models. Thus, it can be assumed that the obtained posterior samples are appropriate for statistical inference.

The results of models estimation have been summarized in Table 1.

In the case of the first age group (18–30 years), based on the highest probability density interval [Bolstad 2007], statistically significant variables are: the age of entering workforce and at least one level of the following predictors: the place of residence, sex, the number of children and the socio-occupational group. As far as the second age group (31–45 years) is concerned, the following determinants are statistically significant: the age of entering workforce and at least one level of the following variables: place of residence, sex, education, socio-occupational group. The results of the third age group (above 45 years) show that place of residence, number of children and socio-occupational group are not statistically significant, and in the case of the remaining predictors at least one level is statistically significant.

6. Conclusions

The results confirm the previous expectation that higher career mobility should be observed in big cities rather than in rural areas. Higher economic growth and the number of different enterprises could have resulted in an increased number of career opportunities. Moreover, this difference is even bigger for young persons. Employees aged under 31 located in big cities changed their jobs 51% more frequently than respondents of the same age group from villages. In the case of the second age group (31–45 years), this difference is still observed but to a lesser degree – only 21%. The difference between small cities and villages for the second age group is 13%. For the remaining age groups this difference is not statistically significant. These results suggest other dependencies than those shown in [Kryńska (Ed.) 2000]. The latter work also included farmers and concluded that career mobility in rural areas is much higher than in big cities. Even though career mobility is partly related to spatial mobility, our research has not confirmed that persons planning to change place of residence had higher career mobility.

The education variable has turned out to be statistically insignificant in the first age group. In the case of all respondents aged over 30, career mobility of individuals who had higher education was larger. In the second age group the graduates aged 31–45 had the number of employment periods higher by 43%, while the persons with a secondary professional education higher by 19% compared to those who attended primary schools only. This tendency is even more evident when persons aged over 45 with higher education status are compared with the respondents with the lowest education status, i.e., having at best primary school only. The persons from the first group have changed jobs almost twice as frequently as the persons from the least educated group. Thus, previous assumptions that university degree may in-

crease the chances for finding potentially better job have been confirmed. At the same time some researchers [Mach et al. 1994] analyzing the period discussed, notice the positive impact of a university degree on career development, but indicate that this impact is observed within the same organization only. As far as our analysis is concerned, the intention to continue education has not been found to have a significant impact on career mobility.

Our research confirms the previous assumption that the sex of the respondent plays an important role in career mobility, but the scale of this impact was also dependent on the age. Men aged below 31 changed jobs more than twice as frequently than women of the same age. For men aged over 31 this difference was only 60–70%. Significant differences are quite obvious, as women usually decide to bear a child when aged under 30. Also results of other research [Mach et al. 1994] show a higher number of employment periods for men as opposed to women. The higher reluctance to change jobs observed among women might be due to the role they play in their families. Women more frequently take care of children, so they do not want to change jobs, as this could mean that they would have less time for their families. Another reason might be discrimination against women in the labour market, as women are promoted less frequently, even if they are better educated and have more professional experience than men.

Our research has not confirmed the remarkable dependencies between the number of children and the number of employment periods in the case of persons aged over 30. However, lower career mobility has been observed for young persons who did not have any children or had a single child. A lack of noticeable relation between fertility and career mobility might be caused by the fact that, during the state-socialism economic period, some of the roles of parents were transferred from parents to the state, thanks to the wide access to social services (nursery schools, kindergartens, schools, extracurricular activities).

In every age group, the respondent's age when entering the workforce had a significant impact on career mobility. Persons starting employment later had a lower number of jobs. The scale of job changes did not depend on the age of the respondent. The respondents who entered the workforce at an older age were probably more anxious about successfully dealing with work responsibilities, because of insufficient experience, as the age of entering employment partly reflects professional experience.

The socio-occupational group that a respondent belonged to at the beginning of his/her professional life has an impact on career mobility. This impact strongly differs depending on the age group. In the case of persons aged under 46 we have determined that persons from lower socio-economic groups, working in industrial and related professions, had lower career mobility rates. Moreover, the respondents employed in commerce, services and transport, changed jobs 30% more frequently than workers in industrial and related sectors. The features of the jobs in these sectors

might have played an important role in this case. This does not contradict results of previous studies [Mach et al. 1994] that show particularly high mobility rates in the mining and steel industry, but only within the same organizations.

To sum up, the Bayesian Poisson regression model used in this study allowed us to investigate dependencies between selected demographic and socio-economic factors and career mobility. Employee mobility is a very wide research topic, usually investigated for specific regions and social groups.

The results of employment mobility studies for the state-socialism period of the Polish economy are frequently divergent [Mach et al. 1994; Kryńska (Ed.) 2000]. This clearly shows that social, demographic and economic processes of the analyzed period have not been fully investigated yet. At the same time, the outcomes of further studies of this period may help to model and promote career mobility nowadays.

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ZASTOSOWANIE METOD BAYESOWSKICH
DO BADANIA MOBILNOŚCI PRACOWNICZEJ POLAKÓW

Streszczenie: Celami opracowania są identyfikacja czynników demograficznych i społeczno-
-ekonomicznych oraz określenie skali ich wpływu na ruchliwość pracowniczą Polaków w la-
tach 1950–1988. Mobilność zawodową modelowano z wykorzystaniem bayesowskiego mo-
delu regresji Poissona. Analizę mobilności pracowniczej przeprowadzono w trzech grupach
wiekowych. Pomimo niewielkiej próby dla trzeciej grupy wiekowej, analiza bayesowska dała
możliwość porównywania otrzymanych wyników. W modelowaniu liczby okresów zatrud-
nienia uwzględniono następujące determinanty: miejsce zamieszkania, płeć, poziom wy-
kształcenia, zamiar dalszej edukacji w ciągu najbliższych dwóch lat, zamiar przeprowadzki
w ciągu najbliższych dwóch lat, posiadanie własnej rodziny, liczbę dzieci w rodzinie, grupę
społeczno-zawodową oraz wiek w chwili podjęcia pierwszej pracy.

Słowa kluczowe: mobilność zawodowa, zmiany pracy, okres socjalizmu, model regresji
Poissona, metody Bayesowskie.