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A LONGITUDINAL STUDY OF POLISH ATTITUDES TO EMIGRATION: A LATENT MARKOV MODEL APPROACH

Abstract

Latent class analysis can be viewed as a special case of model-based clustering for multivariate discrete data. When longitudinal data are to be analysed, the research questions concern some form of change over time. The latent Markov model is a variation of the latent class model that is applied to estimate not only the prevalence of latent class membership, but the incidence of transitions over time in latent class membership.

In 2004, Poland joined the European Union, prompting a number of Poles to leave the country. To examine this event, a model-based clustering approach for grouping and detecting inhomogeneities of public attitudes to emigration from Poland was used. It focuses especially on latent Markov models with covariates, which additionally made it possible to investigate the dynamic pattern of Poles' attitudes to emigration for different demographic features. depmixS4, Rsolnp and LMest packages of R were used.

Keywords: latent Markov model, panel data, model-based clustering, emigration.
JEL Classification: C33, J11.

1. Introduction

On 1 May 2004, ten new countries with a combined population of almost 75 million joined the EU. Since that time, the EU has formed a huge political and economic area with 450 million citizens and included three former Soviet republics (Estonia, Latvia and Lithuania), four post-communist countries (Poland, the Czech Republic, Hungary and Slovakia), a former Yugoslav republic (Slovenia) and two Mediterranean islands (Cyprus and

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Malta). In 2007, Romania and Bulgaria, who were not ready to join in 2004, were admitted. In 2013 Croatia joined the EU.

Closer attention has been devoted to issues of economic migration in Poland since 2006, when it was discovered that mass emigration from Poland and the country's growing economy might lead to a shortage in its workforce (i.e. Budnik 2007, White 2011, Witek 2010).

At least 2.5 million young Poles have left during the past decade, with 300,000 returning, according to the statistics office. After Poland's accession to the European Union, the amount of declared emigration continued to increase. In 2012, 275,603 emigrants officially departed. However, the number of emigrants is considerably underestimated, because we do not have complete insight into the volume of temporary and irregular emigration. Different reports show that it was undeclared emigration that became particularly pronounced during this period and accounted for the majority of emigrants. The temporary migration studies carried out by the Central Statistical Office in 2011 show that for every 1000 inhabitants of Poland, 52 worked abroad for longer than three months, which amounts to 2,017,501 temporary Polish emigrants.

Poland ranks first among postcommunist countries in the number of emigrants it sends forth and the emigration rate[1] (see Figure 1 and Table 1). In comparison with all of the countries that joined the EU in 2004, Poland is fifth, following Cyprus, Lithuania, Latvia and Malta. However, the emigration rate in Poland is currently unprecedented, and has not only remained high, but is growing, while the rate in Lithuania and Latvia have been falling since 2010 (Table 1)[2].

The most common destinations for Polish migrants are the UK, Ireland, Germany, the Netherlands and Sweden (especially for temporary migration). The causes of emigration from Poland are not only economic, but also social, one of the most important reasons cited being the lack of opportunities for self-expression, self-realisation, and interesting creative work.

Emigration poses a serious threat to Poland's socio-economic development. Firstly, it exacerbates the current negative demographic indicators (low birth rate, stagnant average lifespan), which will cause the absolute number of the population to fall. Most young Poles have gone to Britain, where Polish census figures showed Polish women are twice as likely

[1] The number of registered departures from the country for a permanent stay abroad divided by the number of residents.

[2] Data that allow for international comparisons of migration flows in EU countries are available from the European statistics agency, Eurostat.

to have children than in their native country. There is also the threat of the loss of national identity.

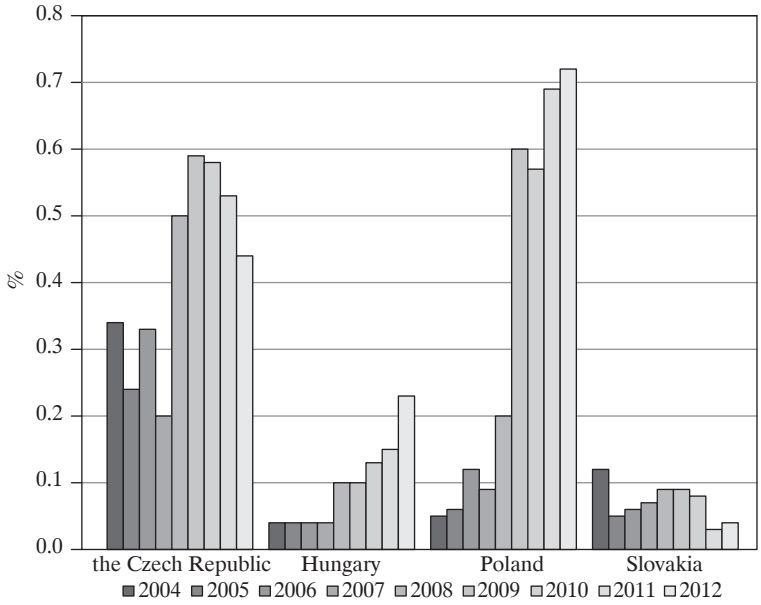

Fig. 1. Emigration Ratio in Post-communist Countries in 2004–2012

Source: author's own calculations based on Eurostat data.

Table 1. The Emigration Ratio for Countries that Joined the UE in 2004 (in %)

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012
The Czech Republic	0.34	0.24	0.33	0.20	0.50	0.59	0.58	0.53	0.44
Estonia	0.21	0.34	0.41	0.33	0.33	0.35	0.40	0.47	0.48
Cyprus	0.87	1.36	0.92	1.50	1.35	1.23	0.52	0.58	2.10
Latvia	0.89	0.78	0.76	0.70	1.23	1.77	1.87	1.46	1.23
Lithuania	1.11	1.73	0.98	0.93	0.80	1.21	2.65	1.76	1.37
Hungary	0.04	0.04	0.04	0.04	0.10	0.10	0.13	0.15	0.23
Malta	–	–	0.47	1.24	0.91	0.94	1.01	0.92	0.96
Poland	0.05	0.06	0.12	0.09	0.0	0.60	0.57	0.69	0.72
Slovenia	0.41	0.43	0.69	0.74	0.60	0.92	0.78	0.59	0.70
Slovakia	0.12	0.05	0.06	0.07	0.09	0.09	0.08	0.03	0.04

Source: author's own calculations based on Eurostat data.

Secondly, changes in the population's age structure directly affect the country's economy. A falling working-age population reduces the state budget and social security budget revenues. The declining workforce and the decreasing number of employed residents also affects the quality and availability of healthcare, which are funded by taxpayers. Moreover, the demand for such services is increasing as the population ages.

Thirdly, the departure of well-educated citizens shrinks the country's intellectual potential and diminishes the opportunity to master and develop advanced technologies and innovations.

To mark Poland's more than 10-year anniversary of EU membership, a model-based clustering approach to detect inhomogeneities of public attitudes to emigration from Poland was used. Despite numerous studies, the Polish migration situation is murky, and, because statistical data record only the officially declared migration, the actual emigration rate remains unclear. Therefore, our empirical research was based on systematic sociological research conducted by Czapiński and Panek (*Diagnoza społeczna 2013*… 2014) in Poland. A particular focus was placed on the latent Markov models with covariates, which additionally made it possible to investigate the dynamic pattern of Polish attitudes to emigration for different demographic features.

2. Definition

The initial formulation of the latent Markov (LM) model introduced by Wiggins (1973) has been developed in several directions, and applied in a number of fields (Bartolucci, Montanari & Pandolfi 2015, Genge 2014, van de Pol & Langeheine 1990, Vermunt, Langeheine & Böckenholt 1999, Visser & Speekenbrink 2010). The LM model represents an important class of models for the analysis of longitudinal data when response variables are categorical. The LM model analyses $P(\mathbf{y}_i)$, the probability function of the vector of responses over time by means of a latent transition structure defined by a first-order Markov process. For each time point t, the model defines one discrete latent variable constituted by K latent classes (which are referred to as latent states).

The model given in (1) relies on two main assumptions: first, it assumes that the latent state transitions occurring over time are modeled using the first-order Markov chain. Second, the latent states are connected to one or more observed response variables via a latent structure with conditional densities. The latter assumption implies that the observations in time t

depend only on the latent states at time t and is often referred to as the local independence assumption, which is the pillar of latent structure models.

Let y_{it} denote the response of subject i at occasion t on response variable j, where $1 \leq i \leq n, 1 \leq t \leq T, 1 \leq j \leq J$, and $1 \leq y_{itj} \leq M_j$, where n is the number of subjects, J is the total number of response variables and M_j is the number of categories for response variable j. The vector of responses for subject i at occasion t is denoted as $\mathbf{y}_{it}$ and the vector of responses at all occasions as $\mathbf{y}_i$.

The latent Markov model can be defined as follows:

$$f(\mathbf{y}_i) = \sum_{x_0=1}^{K} \sum_{x_1=1}^{K} \dots \sum_{x_T=1}^{K} P(x_0) \prod_{t=1}^{T} P(x_t \mid x_{t-1}) \prod_{t=0}^{T} P(y_{itj} \mid x_t). \quad (1)$$

The LMM is characterised by three probability functions:

1) $P(x_0)$ – an initial-state probability, i.e. the probability of having a particular latent initial state at $t = 0$,

2) $P(x_t \mid x_{t-1})$ – a latent transition probability, i.e. the probability of being in a particular latent state at time point t conditional on the latent state at time $t - 1$.

$$\mathbf{A} = \begin{bmatrix} a_{11} & \dots & a_{1K} \\ \vdots & \vdots & \vdots \\ a_{K1} & \dots & a_{KK} \end{bmatrix} \quad (2)$$

Assuming a homogenous transition process with respect to time, the latent transition matrix of transition probabilities a_{sr} was achieved, with $s, r, \dots, K$ denoting the probability of switching from latent state s to latent state r.

3) $P(y_{itj} \mid x_t)$ – a response probability, i.e. the probability of having a particular observed value on response variable j at time point t conditional on the latent state occupied at time point t.

When transitions are added to the latent class model, it is more appropriate to refer to the classes as states. The word class is more associated with a stable trait-like attribute whereas a state can change over time. This is especially useful when a model contains covariates $\mathbf{z}_i$. In depmixS4 package of R, a generalised (multinomial) model logit link function for the effects of covariates on the transition probabilities is employed (see e.g. Agresti 2002, Vermunt 1997). In this case, each row of the transition matrix is parameterised by a baseline category logistic multinomial, meaning that the parameter for the base category is fixed at zero.

The maximum likelihood estimation of the parameters of LM models involves maximizing the log-likelihood function $L(\mathbf{y}) = \sum_{i=1}^{n} \log P(\mathbf{y}_i)$. This

problem can be solved by means of the Expectation-Maximisation (EM) algorithm (Dempster, Laird & Rubin 1977). The E step computes the joint conditional distribution of the $t + 1$ latent variables given the data and the current estimates of the model parameters. In the M step, standard complete data ML methods are used to update the unknown model parameters using expanded data matrix with the estimated densities of the latent variables as weights.

The EM algorithm, however, has some drawbacks: it can be slow to converge, and applying constraints to parameters can be problematic. It can be seen that computation time and computer storage increase with the number of points, which makes the standard EM algorithm impractical or even impossible to apply with more than a few time points (Vermunt, Langeheine & Böckenholt 1999). Therefore, the depmixS4 package of R uses a special variant of the EM algorithm for LM models, called Baum--Welch or forward-backward algorithm (Baum et al. 1970, Paas, Vermunt & Bijmolt 2007).

An important modeling issue is choosing the proper number of states, which is typically based on information criteria such as the Bayesian Information Criterion (BIC) (Schwarz 1978) or Akaike Information Criterion (AIC) (Akaike 1974).

3. Example

The analyses presented below are based on social diagnosis questionnaires. The social diagnosis (objective and subjective quality of life in Poland) is a diagnosis of the conditions and quality of life of Poles as they report it.

The project takes into account all the significant economic – and not strictly economic – aspects of the life of individual households and their members. The project is interdisciplinary, drawing on the work of the main authors of the Social Monitoring Council, which is made up of economists, a demographer, an insurance specialist, a psychologist, sociologists, a health economics expert and statisticians. The social diagnosis is based on panel research with the same households taking part every few years.

Questionnaire items about Polish emigration were considered. The data concern one dichotomous outcome variable y_1 and one multinomial y_2 outcome variable measured at five different times (every two years, i.e. 2005, 2007, 2009, 2011, 2013)[3]. Unfortunately, the information was not complete

[3] Only those two variables are given at five occasions.

for any of the years. Therefore, 538 complete observations were considered at each point of time. In total, there is information on $n = 2690$ cases. The public dataset is available at www.diagnoza.com (see also *Diagnoza społeczna 2013*… 2014).

All computations and graphics in this paper have been done in the depmixS4 (Visser & Speekenbrink 2014) package of R.

The following variables (questions) were used in the analysis for the years 2005, 2007, 2009, 2011 and 2013:

y_1 – Do you plan to go abroad within the next two years in order to work?

y_2 – To which country (economic emigration target)?

The following covariates were also analysed:

z_1 – education[4],

z_2 – age[5],

z_3 – social-professional status[6],

z_4 – occupation (active and inactive)[7].

In the first question, respondents could choose one of two options: yes or no. In the second question, the following countries were considered: Austria, Belgium, Denmark, Finland, France, Greece, Spain, the Netherlands, Ireland, Luxemburg, Germany, Portugal, Sweden, UK, Italy, other UE countries, Norway, the US, Canada, Australia, other countries.

A reasonable theoretical approach might indicate that there are two latent states of survey respondents: emigration enthusiasts and emigration sceptics. Supporters of emigration will tend to respond favourably to the prospect of leaving the country, with the reverse being the case for emigration sceptics. One might further expect that "changing one's mind" and moving into the other group is a function of each individual's education, occupation, social-professional status and age. This hypothesis can be investigated using a latent Markov model.

The optimal number of states was chosen using information criteria for the basic model (Collins & Lanza 2010), so two latent states were chosen.

[4] 1 – primary/no education, 2 – vocational/grammar, 3 – secondary, 4 – higher and post-secondary.

[5] 1 – up to 24 years, 2 – 25–34 years, 3 – 35–44 years, 4 – 45–59 years, 5 – 60–64 years, 6 – 65+ years.

[6] 1 – public sector employees, 2 – private sector employees, 3 – entrepreneurs/self-employed, 4 – farmers, 5 – pensioners, retirees, 7 – pupils and students, 8 – unemployed, 9 – other professionally inactive.

[7] 1 – legislators, senior officials and managers, 2 – professionals, 3 – technicians and associate professionals, 4 – clerks, 5 – service workers and shop sales workers, 6 – skilled agricultural and fishery workers, 7 – craft and related trades workers, 8 – plant and machinery operators and assemblers, 9 – elementary occupations, 10 – armed forces.

Parameters of the two states were estimated using the EM algorithm. In further analyses, the significance of the coefficients was tested. For the two states, only age and occupation coefficients were significantly different from 0. By examining the estimated state-conditional response probabilities, it was confirmed that the model indentified the two groups, with 8% in the pro-emigration group and 92% in the anti-emigration group. The smaller latent state was labelled "emigration enthusiasts" and the bigger group "emigration sceptics".

Latent state 1, emigration supporters, was characterised by a very high probability (98%) of a positive response to the first question about emigration. This state also returned the highest percentage (40%) of respondents prepared to work in Ireland and in Germany (20%), 7% in the US, 6% in Spain, 6% in the Netherlands, 2% in Austria and 2% in Denmark.

In contrast, those in latent state 2, emigration sceptics, were characterized by a low probability (1%) of a positive answer to the first variable. Of those from this group who were prepared to go abroad, nearly everyone (99%) indicated it would be to the US[8].

A further relevant set of information provided by the LM model is represented by the latent transition matrix **A**, which shows the probability of switching from one latent state to another. The results on Polish attitudes to emigration are reported in Table 2. The values on the main diagonal of the transition matrix represent "state persistence" – that is, the probabilities of remaining in a particular state. For example, the probability of staying in latent state 1 is $a_1 = 0.18$, while the probability of remaining in state 2 $a_{22} = 0.93$ is very high. The out-of-diagonal a_{sr} values indicate the probabilities of the emigration state switching: for instance, the attitude to emigration is not well represented by latent state 1 at time $t + 1$ and it is not very likely a persistence of this ready to emigration state but rather a switch to the emigration sceptics state $a_{12} = 0.82$.

It is also interesting that people who are not so ready to leave Poland at time t will not change their mind at time $t + 1$ with probability $a_{22} = 0.93$, indicating their behaviour is stable. They may also shift with the lowest probability to the emigration group represented by state one ($a_{21} = 0.07$).

The final model that was fitted to these data was another two state model with the addition of a covariates effect on the transition probabilities. Whether the effect of education and age modified emigration was the point of interest.

[8] The parameters of an LM model without covariates were also estimated. The estimated class--conditional response probabilities were quite similar to those for the LM model with covariates.

Table 2. Latent Transition Probabilities

State	State 1	State 2
State 1	0.18	0.82
State 2	0.07	0.93

Source: author's own calculations in R.

The hypothesis test showed that the separate variables of age and occupation had an influence on the transition probabilities (these covariates are statistically significant).

To interpret the estimated generalized logit coefficients of covariates, the transition probabilities were calculated and plotted at varying levels of age and occupations. In Figure 2, the estimated transition probabilities are given separately for each age category and level of occupation.

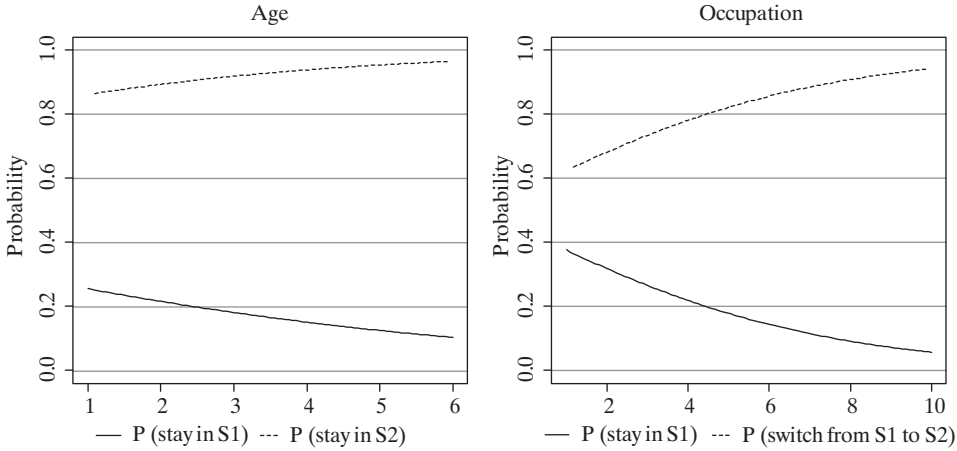

Fig. 2. Predicted Transition Probabilities for Age and Occupation Covariates

Source: author's own calculations in R.

As expected, the probability of remaining in state 1 decreases with age while the probability of remaining in state 2 increases with age (see the left panel of Figure 2). Due to space limitations, not all of the figures are presented here. However, the probability of changing one's attitude to willingly working abroad (a switch from state 2 to state 1) decreases with age while the probability of switching from state 1 to state 2 increase with age. It is likely older people would be less willing to emigrate as they might find adjusting to a new country more difficult than younger people do.

As far as the second significant covariate is concerned, respondents with higher positions are more likely to stay in the emigration state; on the other hand, the lower the position, the higher the probability of switching to state 2 (see the right panel of Figure 2). However, regardless of the position, respondents are very likely to belong to state 2 (a little bit higher for people with the lower position level) and to switch to state 1 (a little bit higher for people with a higher position level).

4. Conclusion

It might be supposed that emigration was a very common phenomenon because of EU borders opening or economic crisis. Despite two decades of uninterrupted growth in their country, however, Polish people are still leaving.

A latent Markov model was used to analyse Polish attitudes to emigration since the country's EU accession. The focused was especially on the variant of an LM model with covariates which additionally made it possible to investigate the dynamic pattern of Polish attitudes to emigration for different demographic features. By examining the estimated class- conditional response probabilities, it was confirmed that society could be divided into two groups. Two states of Poles were found – a pro-emigration state, which was the smaller of the two, and an anti-emigration state. The influence of covariates on the transition probabilities were also shown, representing the stability of behaviours. One hopes that the individuals in the small group of people that is ready to leave the country will change their minds after the latest statistics are released (the National Crime Agency showed the number of potential victims of trafficking last year increased by 22% over 2012 figures). The highest number of people trafficked into the UK (the most popular country of Polish emigration) came from Romania and most of them were sexually exploited. Poland was the most likely country of origin for people facing labour exploitation.

Poland has a negative migration balance. Nevertheless, according to Eurostat, citizens of other countries made up only 0.1% of the Polish population in 2011 – the lowest percentage in the entire EU. Most non-EU immigrants (both legal and otherwise) come from Ukraine, Belarus, Russia, Moldova and Armenia. Ukrainians consistently receive the greatest number of temporary residence permits, as well as settlement permits. They are also the biggest migrant group on the Polish labour market. Poland has successfully integrated thousands of people who have come to Poland from

Eastern Europe and have made a home here. Some have Polish roots or have relatives in Poland, like the group recently evacuated from Donbass, fleeing the fighting with Russia-backed separatists.

However, according to a study in 2013 by the Centre for Research on Prejudice – a professional academic centre at the University of Warsaw – as many as 69% of Poles do not want non-white people living in their country. They fear other religions and traditions. A vast majority believe that immigrants take work away from Poles and that their presence is detrimental to the economy. It's a view shared more broadly in Eastern Europe, despite insignificant migrant flows in all of Poland's eastern neighbours.

Poland's migration policy can generally be described as relatively restrictive and is addressed towards non-EU citizens, mostly from neighbouring Eastern European countries. Poland needs a complex endeavour to identify migrants who really need to be protected and to prepare centers that would house them. Concerning mentality, it may be supposed that public debate or an immigration campaign (explaining the moral and formal obligations of EU countries) will bring changes in the future.

Future research could be done to analyse migration data using a variant of the Latent Markov model including time-constant and time-varying covariates as well, where both initial-state and transition probabilities are allowed to differ for each latent state (Bartolucci, Farcomeni & Pennoni 2013).

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Abstract

Analiza nastawienia Polaków do emigracji z wykorzystaniem ukrytych modeli Markowa

Modele mieszanek, których składowe charakteryzowane są przez rozkłady prawdopodobieństw, reprezentują tzw. podejście modelowe w taksonomii. Obecnie coraz popularniejsze są modele mieszanek w analizie danych panelowych, w której celem jest

już nie tylko podział obserwacji na homogeniczne grupy, ale również pewna analiza zmian w czasie. W takim przypadku stosowane są ukryte modele Markowa.

W 2014 r. minęło 10 lat od przystąpienia Polski do Unii Europejskiej. Okres taki pozwala na dokonanie analizy nastawienia Polaków do emigracji. Celem badań jest podział Polaków na klasy o podobnym nastawieniu do emigracji w latach 2004–2013. Analiza empiryczna przeprowadzona została za pomocą ukrytych modeli Markowa z uwzględnieniem zmiennych towarzyszących. Wykorzystane zostały pakiety depmixS4, Rsolnp oraz LMest programu R.

Słowa kluczowe: ukryty model Markowa, dane panelowe, podejście modelowe w taksonomii, emigracja.