THE DRAFT VERSION OF PAPER

Fertility and socioeconomic gender equality among couples– Bayesian analysis of three European countries[1]

Beata Osiewalska[2]

Cracow University of Economics

b.osiewalska@gmail.com

ABSTRACT

The association between couples' socioeconomic characteristics and fertility has been subject to changes over the past centuries. In historical societies and in small scale contemporary populations a positive connection was revealed, while in modern, highly developed countries the association seems to be conflicting and equivocal. Examining the procreative behavior among men and women has led to the clearly different results driven mainly by socioeconomic sex-specific association with childlessness (a high risk of childlessness among men with low socioeconomic status and a low risk of childlessness among women with low status). While the gender differences have been examining quite deeply, couples' procreative behaviors treated as a result of conflict between male and female socioeconomic features still remains an understudied topic. Thus, the aim of my research is to investigate couples' reproductive behaviors among contemporary European populations, distinguishing two states: childlessness and parenthood, with regard to the gap between partners' socioeconomic features. Consequently, the special attention will be given not only to the separate effect of male and female characteristics, but rather to the impact of the distribution of partners' socioeconomic status (socioeconomically hyper- and hypogamous couples) on their fertility.

I. INTRODUCTION

The connection between socioeconomic status and reproductive behaviors among contemporary populations strongly attracts research interests and still remains a controversial topic. Nowadays this research problem in developed societies is particularly important mainly due to the very low fertility, which does not guarantee even the population replacement level. As a result of previous studies conducted at different times, social and economic conditions were indicated as one of the most important or even crucial determinants of fertility.

Among the results of previous researches, special attention should be given to the relationship between family size and individual's socioeconomic status, measured mainly by the level of education

[1] The paper was prepared during the European Doctoral School of Demography (EDSD) 2013/2014 under the supervision of Laurent Touleman (Institut National Etudes Démographiques) and Krzysztof Tymicki (Warsaw School of Economics). The Author wants to thank the Supervisors for their invaluable comments and time devoted to work with the topic. The study is a part of the PhD project "Couple childlessness and parenthood as a result of partners' socioeconomic status in selected European countries – Bayesian view".

[2] Ph.D. student at Cracow University of Economics, Poland, participant of EDSD 2013/2014

and income. In historical societies and in small-scale contemporary populations a positive association between socioeconomic status and the number of children was revealed (Cronk 1991, Gurven and von Rueden 2006, Skirbekk 2008, von Rueden et al. 2011). However, in modern, highly developed societies this association seems to be negative. Such relationship is very often explained by the higher alternative costs of having children (opportunity costs) among individuals with higher socioeconomic status. Moreover, in these societies, special importance is attached to investment in the child (education, health), which in turn contributes to an increase in child costs and, consequently, to the reduction of number of offspring (Becker 1960).

In literature connected with various determinants of reproductive behaviors a special place is owned to economic theory by G. Becker (Becker 1960). This theory is based on the assumption that the decision to have a child is a rational decision regarding the use of limited resources. Then, if we assume that the child is a consumer good, the growth in income should lead to an increase in demand for children ("income" effect). However, Becker emphasizes that, in the case of women, growth in income due to growing alternative costs of having children can lead to a different situation. For educated and working women time costs and the opportunity costs of being a mother are very high (Becker 1960, 1991). Therefore Becker linked the decrease in the fertility level in developed societies with improvement in socioeconomic status of women ("substitution" effect).

Changes in modern demographic behaviors observed in developed, particularly European societies were described and explained by the theory of the second demographic transition (see Van de Kaa 1987, 1997, 1999, Lesthaeghe 1983, Lesthaeghe and Moors 1996). The authors of the concept claim that the contemporary family model was developed by the processes observed as: 1) co-occurrence of marriages and other widely spreading forms of families (cohabitation, relationships called Living Apart-Together – LAT), 2) depriving a child a central place in the family – this place took a couple, 3) replacing preventive contraception by conscious decisions about the number of offspring and their time coming into the world, 4) replacing a single model of the family (parents and children) by various forms of family life (Van de Kaa DJ 1987). The observed changes are realized in the three layers: structural (society's urbanization, increase in welfare), technological (effective contraception) and cultural (the ideas of equality, freedom, self-fulfillment). Under these conditions, a need to reconcile women's and men's different careers is particularly important. These carriers have occurred as a result of different social and parenting roles and growing partners' independence and freedom of choices.

Changes in social and economic roles of women and men together with their impact on reproductive behaviors of modern societies have been included in the gender equity theory created by P. McDonald (2000a, 2000b, 2006). The author emphasized that in contemporary populations, because of the changes in human's attitudes and beliefs, the traditional family model (in which a man was responsible for ensuring proper life conditions) was rejected. The roles of a man and a woman in a relationship started to intertwine and became equivalent in terms of socioeconomic conditions.

Unfortunately, changes in social institutions often do not match the needs of a new mentality. While the institutions that are focused on the individual (as education, labor market) treat the roles of women and men equally, the institutions that work on behalf of the family members (social insurance, taxes and employment conditions) still keep differences in the understanding of the role of women and men in a relationship. Therefore, a woman has access to the same opportunities as a man, but her development is clearly limited by the fact of having a child. This leads to a reduction of fertility level, particularly in those countries in which the family system is highly traditional, e.g. Eastern or Southern European countries (see Matysiak and Vignoli 2013).

A particularly important issue of modern reproductive behaviors among highly developed societies is the problem of childlessness. It primarily appeared because the aim of building the relationship is no longer only procreation, but also the joint implementation of other life goals (Baudin et al. 2012). These other objectives may lead to the postponement of parenthood or to a conscious resign from being a parent (compare Van Bavel 2012, Mynarska 2010, Mynarska and Matysiak 2010). Both of these behaviors increase the risk of childlessness. At the time when parenthood is being postponed, various unfavorable future conditions are not considered. These conditions could be, e.g., the difficulty with finding a suitable partner, breaking the relationship, deterioration of health or economic situation. In both cases (conscious resignation, postponement) we deal with different determinants of reproductive behaviors. It should be also noted that the procreative behaviors have different nature among population without children than among population already having experience with parenting. In the first case it is a transition to the state of becoming a parent, and in the second it is enlarging the existing family.

In previously discussed approaches parental couple is treated usually as a unity, without distinguishing between socioeconomic status of a mother and a father. Such an approach can be justified by an asymmetric division of gender roles, when the responsibility for creating the proper daily life conditions belongs to a man, while maintaining a household and taking care of others belongs to a woman. However, in developed societies that division is no longer valid and the more symmetric distribution of gender roles is observed. Equal gender roles that allow to achieve adequate socioeconomic status not only by a man, but also by a woman, requires formulation of the analyzed problem in a different way (Hobcroft 2006). It was revealed that in developed countries the relationship between family size and its socioeconomic status seems to be equivocal, especially when analyses are stratified by sex. It was noted that among women correlation between the socioeconomic status and the number of children is clearly negative (Weeden et al. 2006, Fieder and Huber 2007, Nettle and Pollet 2008), while among men remains positive (Fieder et al. 2005, Weeden et al. 2006, Nettle and Pollet 2008). It was suggested that these differences are caused by socioeconomic sex-specific associations with childlessness, mainly, the subpopulation of childless men with low socioeconomic status have a high risk of being childless (while women with low status have a low risk) and excluding them from the analyses led to the same results as among women (negative

correlation). In turn, the results obtained for women are the same among subpopulation of childless women and among mothers (Fieder and Huber 2007, Barthold et al. 2012). Still, there is lack of studies that could explain the association between fertility of a couple and the socioeconomic characteristics of both partners included together (Van Bavel 2012). Whose characteristics are more influential? What would happen with fertility of a couple in which a woman has higher socioeconomic status than a man? Which types of couples are more likely to stay childless? This "couples" approach seems to be important due to the fact that in modern societies fertility decisions are not taken solely by men or solely by women, but they are the result of mutual preferences and compromises between both of potential parents (taking into account the individual opportunity costs of both sides). Therefore, the relative socioeconomic characteristics (compared to the partner's characteristics) could impact the reproductive behavior even stronger than the absolute values. What is more, by measuring the gap between partners' socioeconomic features we actually can measure the socioeconomic gender equality within a couple.

The next section (section II) introduces the aim of the study and discusses in details the hypotheses considered during the research. Section III describes the data used in the study together with the set of covariates and brief description of methodology. Section IV presents the estimations of the models and comments on results. Section V demonstrates general conclusions.

II. AIM AND HYPOTHESES

The aim of this study is to investigate couples' procreative behaviors among contemporary European populations (in case of Austria, Bulgaria and France) with regard to the gap between socioeconomic features of each partner, and consequently to determine whether the gender equality or inequality in socioeconomic characteristics influence fertility behavior in a relationship. To clarify, the interest of the study is to determine the influence of social and economic variables describing the status of a woman and a man (such as education, income, activity status) on the mutual couples' reproductive behavior (number of children). Socioeconomic characteristics of a couple and household, e.g., living floor space, ownership flat/house status, cost of childcare will be included as a control variables. Additionally, to simulate the reproductive behavior according to levels of adopted characteristics, several couple's profiles will be presented (e.g. socioeconomic homogamy between partners, female hypergamy/hypogamy[3], etc.). It should be mentioned that this paper is a draft version and concentrates mainly on the theoretical part of the study, that includes background of the research, formulating hypotheses and building a model, while the computational part will be presented very briefly with only preliminary results that will be extended in the future research from a wider perspective.

[3] Female hypergamy – women tend to marry more educated men. Male hypogamy – men tend to marry less educated women.

In this study socioeconomic status of a couple will be defined mainly by the educational level of both partners. Obtaining subsequent levels of education very often goes together with formation of the preferences connected with family and children. That is why, education is considered as the characteristic that influences and shapes fertility from their basis (already on the level of formation the preferences). Besides the education, socioeconomic status will include both partners' income and activity status. Higher income gives the opportunity to maintain bigger family, but at the same time together with higher income the opportunity costs of having children increase, especially for women. Thus, not only the level of income is important but also its distribution between partners. Finally, when both partners work and earn money the financial stability of a couple is higher. That creates the encouraging conditions to have more children, but on the other hand, could also restrain fertility (cause of opportunity costs).

All these variables that are expected to determine the socioeconomic status of a couple[4] will be included separately into the analyses. Building and including in a model only an index that reflects the socioeconomic status of a couple could make the analyses easier and allow to interpret the results in a more straightforward way. What is more, it could be useful to lower the number of model's parameters that could be necessary in case of many other variables of interest. However, considering all variables separately brings more detailed results that in fact allow to build the most relevant index (the obtained model's coefficients are nothing else but "weights" included in the index). Consequently, if there are no computational problems caused by surfeit of parameters, it is advised to include variables separately.

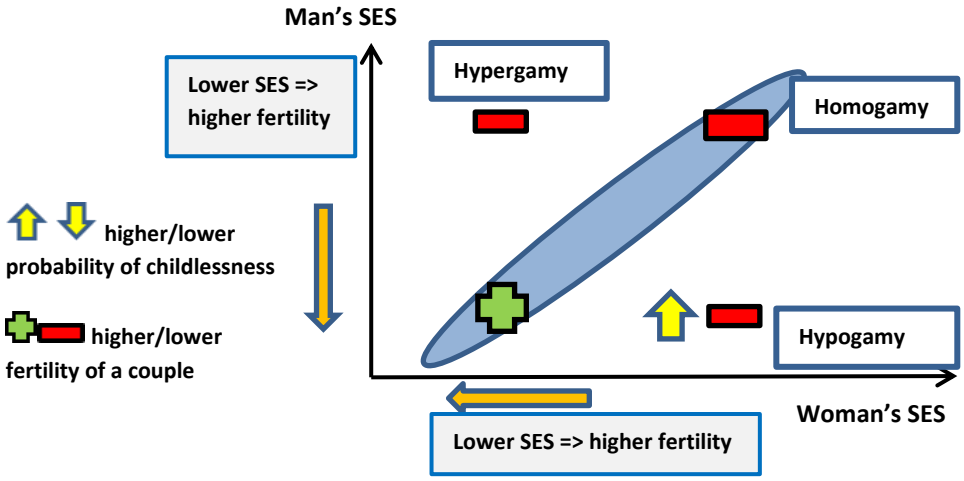
Two main areas of interest will be considered during this analysis. The first one is the fertility dimension that is directly connected with the type of response variable. Within this dimension there will be measured the total fertility of a couple (the total actual number of children than a couple have), the probability of being childless (that will be measured within the childlessness state) and mean fertility for couples with children (parenthood state). The second dimension is connected with socioeconomic status of a couple and will cover the analyses of differences between hypergamous and hypogamous couples as well as between low and high couple's socioeconomic status.

Based on the previous researches on the impact of socioeconomic conditions on fertility, the following hypotheses are formulated. Firstly, in recent decades among the subpopulation of parents the negative influence of men's and women's status on fertility has been observed (Barthold et al. 2012). This result leads to the following hypothesis (1a): within parenthood, couples with the same low socioeconomic status of both partners have the highest actual number of children, while the lowest number of children belongs to socioeconomically homogamous high status couples. In turn, among childless couples the positive influence of men's socioeconomic status and negative influence of

[4] In this study the education, income and activity status of each partner are considered. The other variables, that could influence the socioeconomic status of an individual, like e.g., occupational status (own, partner' or parents'), will be considered as well in the Author's PhD research.

women's status on fertility was discovered. It suggests that (1b) among couples without parenthood experience the highest probability of being childless comes together with female hypogamous socioeconomic status. These general hypotheses, summarized on Figure 1, are expected to be relevant in Austria.

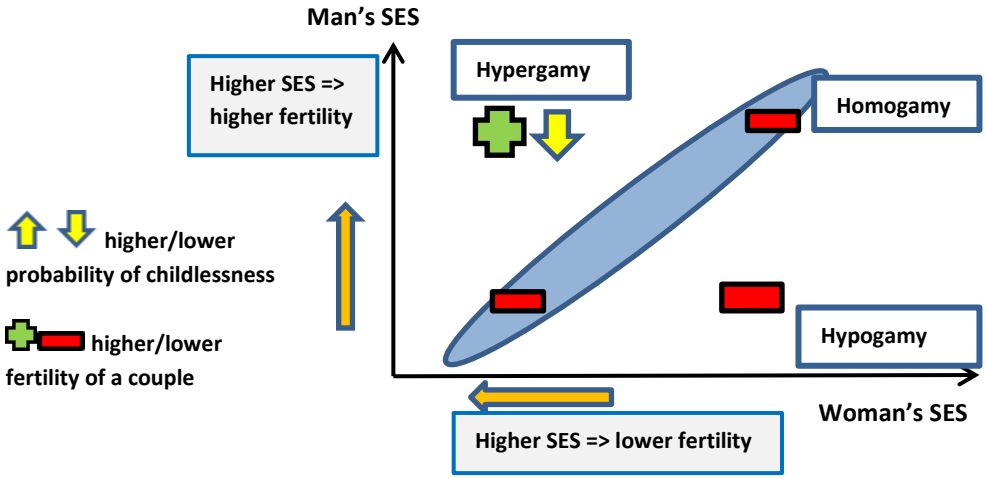
Figure 1. The expected relation between partners' socioeconomic status (SES) and fertility in Austria



Source: Author's elaboration

On the other hand, in countries with positive perception of gender-specific roles within a couple (e.g., France), the relation between socioeconomic status and fertility could differ. (2a) The attachment to the traditional gender tasks division, in which women are supposed to take care of children and men to maintain the family, leads to clear rules between partners and could result with higher actual number of children among female hypergamous couples than among hypo- or homogamous unions. Consequently, (2b) in countries with traditional gender roles, the probability of being childless among hypergamous couples is expected to be lower than among homogamous or hypogamous partners. These expectations are summarized on the Figure 2.

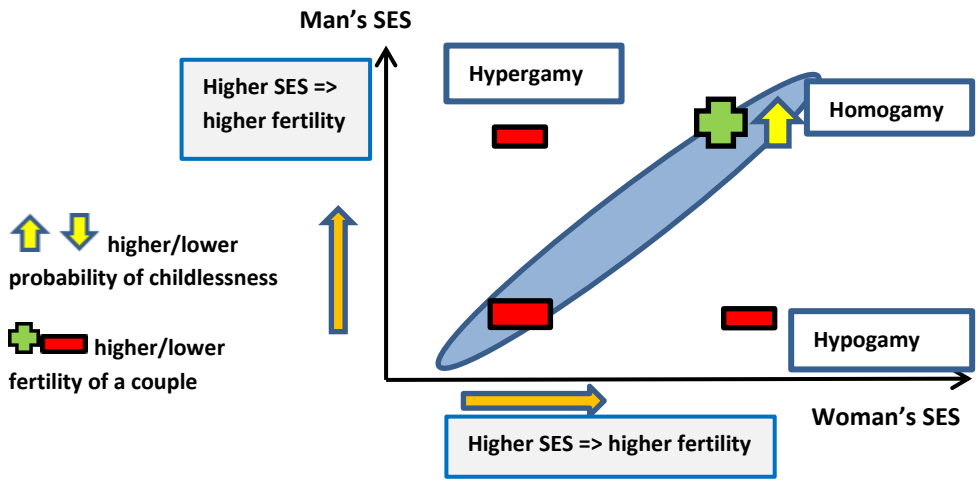
Figure 2. The expected relation between partners' socioeconomic status (SES) and fertility in France



Source: Author's elaboration

Finally, it is expected that in post-soviet countries (Bulgaria) the considered relations could be more mixed. Females' labour participation was treated as a norm and it strongly influenced the change from the traditional, men-breadwinner family model, to the two-breadwinners model. On the other hand, still the perception of gender roles regarding the housework and children is traditional (belonging to a woman). These could result in considering women as a "secondary" breadwinners, with higher importance given to the status of men, but with a positive perception of supplementing the family budget by females. Thus, (3a) because of higher couple's wealth and less uncertainty about the future, I expect to find the positive effect of female's socioeconomic status as well as male's socioeconomic status on the fertility of a couple (as compared to positive "income effect" described by Becker 1993). On the other hand, with higher female's and male's socioeconomic status comes higher probability of staying childless. Partners with the same, high socioeconomic status have also similar high opportunity costs of having a child. In case of high uncertainty about future many couples could be afraid of opportunity costs of having a child. When neither male nor female would be ready to take care of children, this situation may lead to the postponement of childbearing and finally even to remain childless. That is why (3b) it is expected that homogamous high status couples have the highest probability of staying childless (see Figure 3).

Figure 3. The expected relation between partners' socioeconomic status (SES) and fertility in Bulgaria



Source: Author's elaboration

Subsequently, in contemporary populations the female socioeconomic hypogamy (female has higher status than male) becomes more often than in previous decades. The consequences of that change could be as follows. (4a) When a woman becomes a main breadwinner in a household, a couple's fertility, on the one hand, is expected to be lower (cause of the higher opportunity costs for women), especially in countries with strong gender roles division (men do not prone to take females role). However, it was also suggested in previous literature that the relation between fertility and

gender equity in housework is U-shaped – which means that fertility is higher for traditional male breadwinner family model as well as for non-traditional model, with man being a homemaker (Torr and Short 2004, Cooke 2009). Thus, we might expect the fertility-enhancing effect among couples in which men with less education are ready to take fair share of childcare and housework (van Bavel 2012). Therefore, the next hypothesis is as follows: (4b) with the ongoing changes in gender roles, men with lower that their partners socioeconomic status are expected to more often take care of children and involve in housework and consequently they are expected to contribute to the higher fertility of a couple.

Finally, reproductive decisions are taken together by both a female and a male, and usually the final say belongs to the partner with higher relative resources (van Bavel 2012). Therefore, it is expected that (5) the socioeconomic status of both partners has an impact on the actual number of children within a couple and the importance of that influence increases together with a partner's status (the higher status of a partner, the greater influence).

In view of not sufficient studies on the relation between the actual number of children and socioeconomic gender (in)equality with regard to childlessness and parenthood of couples this paper (and its future extensions) will contribute to the current knowledge by the attempt to fill this gap. It will help to draw key conclusions on contemporary reproductive behavior in couples, together with an indication of the similarities and dissimilarities between considered European countries. The impact of socioeconomic status of both partners on their family model, including the connection with childlessness and parenthood, will be characterized.

III. METHODOLOGY

To verify the hypotheses mentioned in the previous section the Zero-Inflated Poisson (ZIP) model will be used (see Lambert 1992). The model is based on standard Poisson regression model but with different component for zeros. It is important that the specification of model allows treating childlessness as a qualitatively different state than having children. It means that the ZIP model gives the opportunity to set up other determinants in modeling zero than in analyzing parenthood and simultaneously to still consider childlessness and parenthood as two state of the same process (fertility). In order to make formal inference about uncertainty of covariates and nonlinear function of the model parameters (such as probability of childlessness or expected number of children) as well as to incorporate our prior knowledge Bayesian approach will be applied. Thus it will be possible to determine the distribution of the posterior expected number of children for a chosen couple's socioeconomic profile.

Data and covariates

The data coming from the first wave of *Generations and Gender Survey* for Austria, France and Bulgaria were used. GGS is conducted in the framework of the international Generations and

Gender Programme (GGP). The program was initiated in the 2000, and its aim is to implement the panel surveys consisting of at least 3 rounds, which are carried out every three years in different countries participating in the study. In addition, the program aims to create a database containing harmonized data on the socioeconomic and cultural conditions in these countries. So far, the first wave data were collected for 16 European countries (Austria, Bulgaria, Belgium, Czech Republic, Estonia, France, Georgia, Germany, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Romania, Russia), as well as from Japan and Australia. Data from the second round are now available for 8 countries (Australia, Bulgaria, France, Georgia, Germany, Hungary, Lithuania and the Netherlands). The first wave is also being tested and preparing in Slovenia and Sweden.

GGS survey is based on large representative random samples. In each country for the first round are engaged approximately 10 000 people aged 18 to 79 years. In every round the same group of respondents are being interviewed. Questionnaires consist of several modules, that include a wide range of social, economic and cultural characteristics. In the context of this study, it is essential that the survey provides information on the creation, development and disintegration of families, the relationship between the generations, changes in social roles of men and women, labor market, health and prosperity status.

In this study, to analyse the pattern observed in Western European countries as well as post-soviet Eastern European countries, the representatives of both areas are included. These are: Austria and France for Western Europe and Bulgaria for Eastern Europe. From the original dataset only respondents who are aged 18-45[5] and stay in a relationship will be analysed. It should be mentioned that fertility for people aged 18-45 cannot be treated as completed. However, among population in active reproductive ages we are able to compare couples' fertility regarding socioeconomic status within particular age groups. This corresponds to the "tempo effect". It means that, for instance, *higher probability of childlessness for a couple with chosen characteristics* will stand for *higher probability of being childless of a couple at a particular age group as compared to the others at the same age* and not for being permanently childless. The "quantum effect" could be analysed among people over the age of 45, cause their fertility could be already treated as completed. The tempo and quantum effects will be considered in more details in the future research.

There are four different sets of covariates considered in the analysis. The first group consists of socioeconomic characteristic of both partners. There are: education of a woman and a man in a couple, income (monthly salary in intervals) and activity status (unemployed, not active) at the moment of the interview. It is important to notify that while education could be treated as completed before starting a family and, once obtained, could not be depreciated, income and activity status are subject to changes. What is more, the causality between number of children and income or activity

[5] Austrian GGS includes only respondents between 18 and 45 years old, while in Bulgaria and France respondents are aged 18-79. Therefore in this analysis, to make results comparable between countries, only respondents aged 18-45 from Bulgaria and France were taken under consideration.

status could go in both directions: the second could determine the first (income and activity status influence fertility), but also the first could influence the second (the bigger family could create pressure on higher income or being housewife/homemaker). The studied dataset is not sufficient to capture this causality. That is why, in this study, by considering income or activity status, we can only measure their association with fertility, but nothing could be said about causality. Still, these variables, even at the moment of interview give us the overall, approximate picture of socioeconomic status of a couple, which often could not greatly change during the lifetime, so it is worth to include them in the analysis and determine the possible association with fertility. The causality problem mentioned above will be analysed deeper using at least two waves of GGS in the next round of analyses.

The second group of covariates includes characteristics of socioeconomic features of a household, such as: type of settlement, living floor space, ownership status of flat/house, whether the household members pool money with each other or keep their money for themselves, if the household are able to save the money, second car ownership, second home ownership, household total income. Within the third group other couple's characteristics are included: marital status, age of a woman and a man (both standardized), stability of the relationship (whether respondent thought about breaking the relationship down during past 12 months). Finally, the fourth group includes covariates defined only for parenthood: institutional help for child care (whether a couple uses the institutional childcare system), friends' or relatives' help for child care, cost of child care.

Zero-Inflated Poisson model with Bayesian approach

To analyse reproductive behaviors in selected European countries and to distinguish childlessness and parenthood as two separate states, Zero Inflated Poisson model (ZIP) will be used (see Lambert 1992). Two different states can be distinguished in the ZIP model. The first one is zero state, which in fertility analysis can be interpreted as childlessness. It is occurring with a probability p (probability of childlessness). The second state, that relates to the values greater than zero (1,2, ...), represents parenthood. It is characterized by a probability that is analogous to the standard Poisson distribution, but is scaled by the probability of parenthood (1-p). Thus, the idea behind ZIP model is to join two different statistical distributions: the Poisson distribution and the binomial distribution (0-1).

Let the independent variables $Y=[Y_1,\ldots,Y_n]$ are derived from the Zero-Inflated Poisson distribution. ZIP distribution for the variable Y_i can be represented as follows:

$$P(Y_i=y_i)=\begin{cases} p_i, & y_i=0 \\ (1-p_i)\dfrac{\exp(-\lambda_i)\lambda_i^{y_i}}{y_i!}, & y_i=1,2,\ldots,\ p_i\in[0,1]. \end{cases}$$

The regressions for zero and count state are included in the following form:

$$p_i=\frac{\exp(\gamma)}{1+\exp(\gamma)},\ \lambda_i=\exp(\delta),\ i=1,\ldots,n,$$

where x_i and w_i are vectors of covariates and γ and ∂ are vectors of parameters. The coefficients estimated in the zero state are interpreted as in a logistic regression, while the coefficients for the count state have the same interpretation as in a standard Poisson regression.

Application of the Bayesian methodology in this study is justified mainly by the ability to formulate fully probabilistic conclusions (based on full distributions) for all of the estimated values, as well as their linear and nonlinear functions. It is particularly relevant for ZIP models, in which probabilities (like e.g., probability of childlessness) are under the main interest. Computing the precise distributions (especially precise uncertainty) is highly important. What is more, using Bayesian approach there is no longer a need to rely on the asymptotic properties of estimators (the main assumption of classical approach), which we can never be sure they are satisfied. The next advantage of Bayesian inference is the possibility of inclusion in the statistical model the prior knowledge – in our study it will be the knowledge about probability of childlessness, the average number of children (λ) and, finally, the average expected family size.

The main idea behind Bayesian approach is very intuitive. Estimation of model's parameters is based on determining the conditional density of parameters given the observations vector, so called posterior distribution, from the join density of parameters and observations. The posterior distribution is than proportional to the likelihood function multiplied by the prior distribution of parameters. Thus, both data and prior knowledge are included in the statistical model with the same level of importance. More details about the Bayesian approach and methods used in the study could be found in the Appendix A.

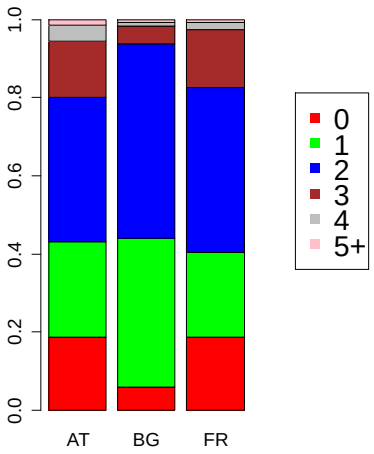
IV. RESULTS

Population structure

Figures 4 to 7 show the structure of the sample population regarding the selected main variables (detailed structure could be found in Appendix B). First, the *number of children ever born* is presented in Figure 4. In all analyzed countries having two children is the most typical family model. The biggest share of childless couples is observed in Austria and France (almost 20%), the lowest is noticed in Bulgaria (6%). On the other hand in Bulgaria there are very few couples with more than 2 children, while in France and Austria bigger families are more common.

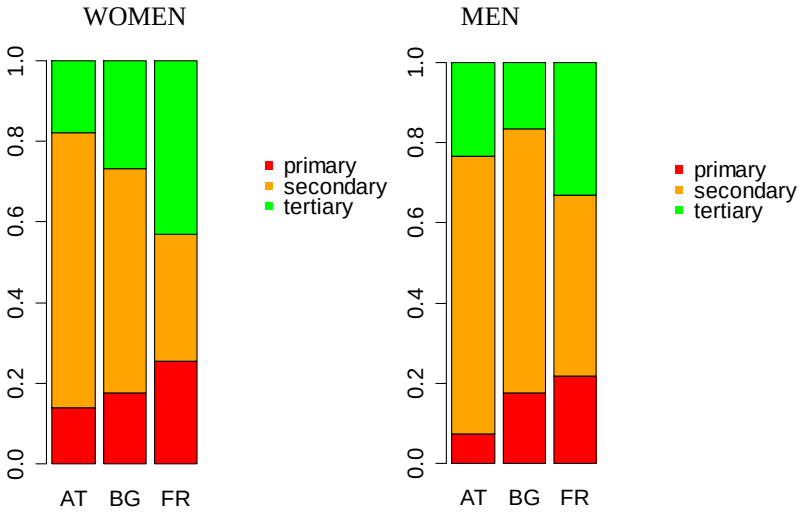
The structure of analyzed population by *education* and sex in all analyzed countries is presented in Figure 5. We can see that in Bulgaria and France there are more highly educated women than men (so the reversal of the gender gap in education is observed), while the opposite is true for Austria. In France women with tertiary education are even the biggest group among all educational level.

Figure 4. The number of children ever born



Source: Author's own elaboration

Figure 5. Educational level by sex

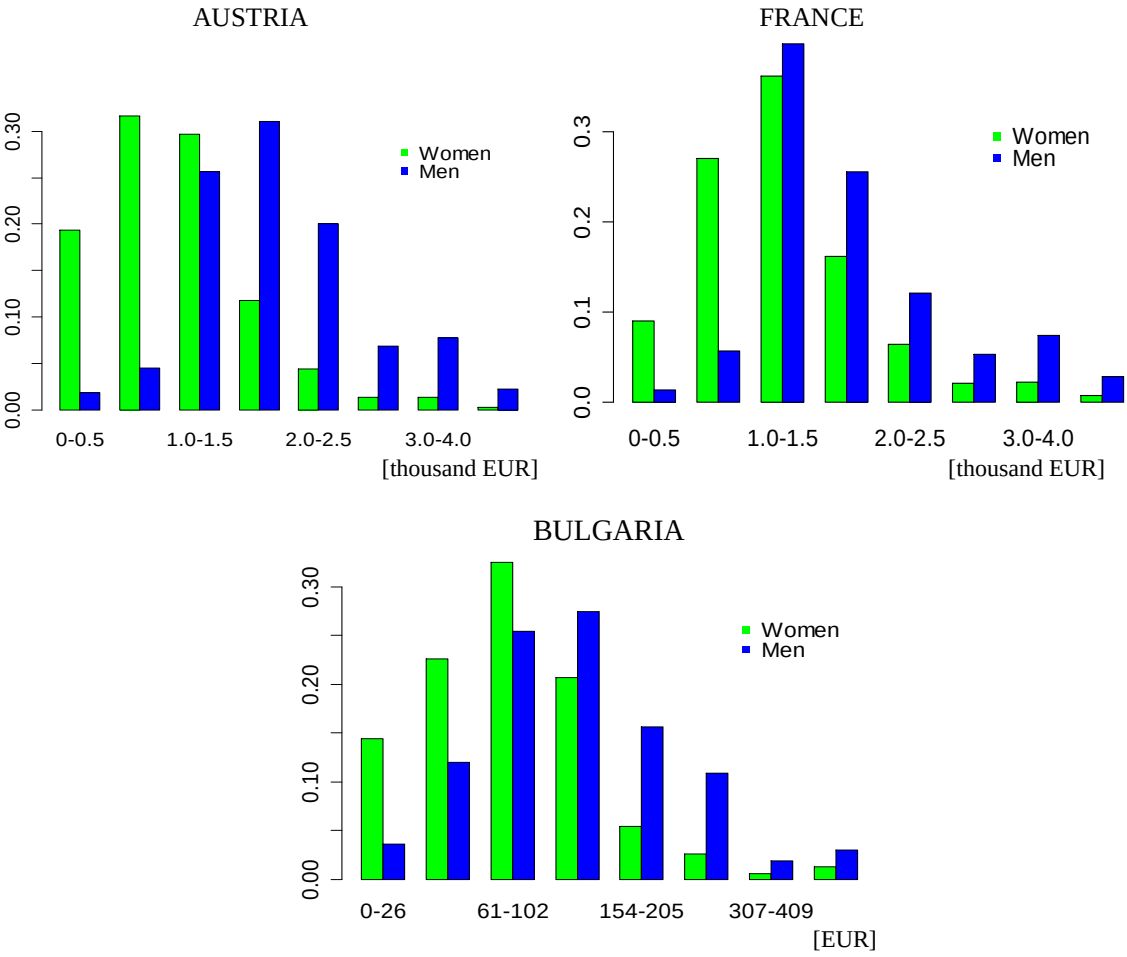


Source: Author's own elaboration

The structure by *income* and sex in subsequent countries is presented in Figure 6. The gender gap in income is still strongly visible in all considered countries, with the biggest difference observed in Austria and Bulgaria.

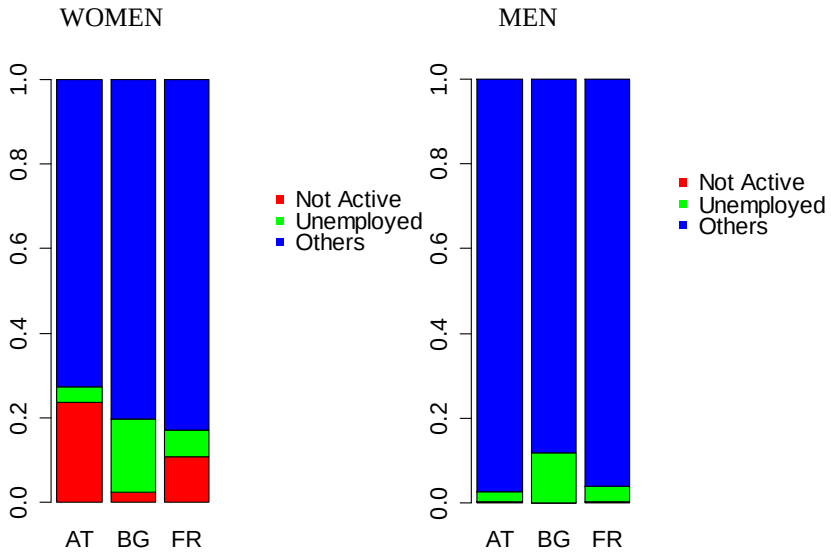
Finally, the structure of population by *activity status* and sex is shown in Figure 7. Surprisingly, in Bulgaria there are more unemployed women than not active women (housewives, being on maternity leaves). In Austria, on the other hand, the highest share of not active women is noticed, while there is very few unemployed females. Among males being a homemaker or staying with children during paternity leave is still not very popular, only few cases are visible in Austria and France.

Figure 6. Income distribution by sex



Source: Author's own elaboration

Figure 7. Activity status by sex



Source: Author's own elaboration

Preliminary posterior results

The chosen posterior results provided for Austria, Bulgaria and France are shown in the Table 1 (detailed posterior distributions for all considered covariates are presented in Appendix C).

Table 1. The *a posteriori* expected values of parameters within zero and count state regressions. Model run on the dataset for Austria (2767 couples), Bulgaria (2826) and France (1839).

Variable	CHILDLESSNESS			PARENTHOOD		
	Austria	Bulgaria	France	Austria	Bulgaria	France
Female:						
Education	0.257***	0.169**	0.025	-0.077***	-0.129***	-0.010
Income	0.538***	0.159**	0.110**	-0.081***	0.037**	-0.529***
Unemployed	0.135	-0.709***	-0.377+	-0.051	0.173***	0.004
Housewife	-2.910***	-1.718***	-1.678***	0.169***	0.084	0.221***
Male:						
Education	0.234**	-0.087	0.101**	-0.068***	-0.042**	-0.021**
Income	-0.099	-0.014	-0.160***	-0.038*	-0.007	0.021*
Unemployed	0.095	-0.315	-0.038	0.119	0.162***	0.012
Homemaker	-0.866	-0.054	-0.917	0.127	0.047	0.125

Note:

1. Highest Posterior Density (HPD) quantiles: '***' – 0.001; '**' – 0.01; '*' – 0.05; '+' – 0.1
2. Control variables: a) socioeconomic characteristics: type of settlement, living floor space, ownership status, pooling the money, saving the money, second car, second home, hh total income; b) other – marital status, age of woman, age of man, stability of the relationship; c) defined only for parenthood: institutional help for child care, friends'/relatives' help for child care, cost of child care.

The analysis confirmed that the couple's family model is driven by gender specific socioeconomic features. The strength of that influence varies across countries. In France, where traditional gender role (man as a head of the family) is popular, it occurred that male socioeconomic features determine the couple's reproductive behavior much stronger than in other countries. What is more, in France the correlation between man's income and fertility (both states: childlessness and parenthood) has the opposite direction than among women and is negative for childlessness (higher man's income is associated with lower probability of being childless) and positive for parenthood (higher man's income is connected with bigger family).

Among all analyzed countries activity status of a woman occurred to be much more important than man's activity status. In particular, being a housewife is strongly associated with the higher average number of children in Austria and France. However, the interesting results was provided for Bulgaria – it was revealed that being a housewife in that country is not significant for the family model, so it does not have any connection with higher average number of children. Additionally, when among other countries higher woman's income leads to the lower number of children, in Bulgaria the

connection is opposite – female income has positive influence on the average number of children. It suggests that in Bulgaria working man is not able to maintain a big family without the financial support from his wife/cohabitee.

Additionally, it occurred that childlessness is much stronger influenced by female characteristics, so within a couple it is mainly a woman who determines whether they should still stay childless or whether it is the proper time to have the first child. When it comes to parenthood, both male and female characteristics are important, so a man seems to play an important role in keeping already existing family.

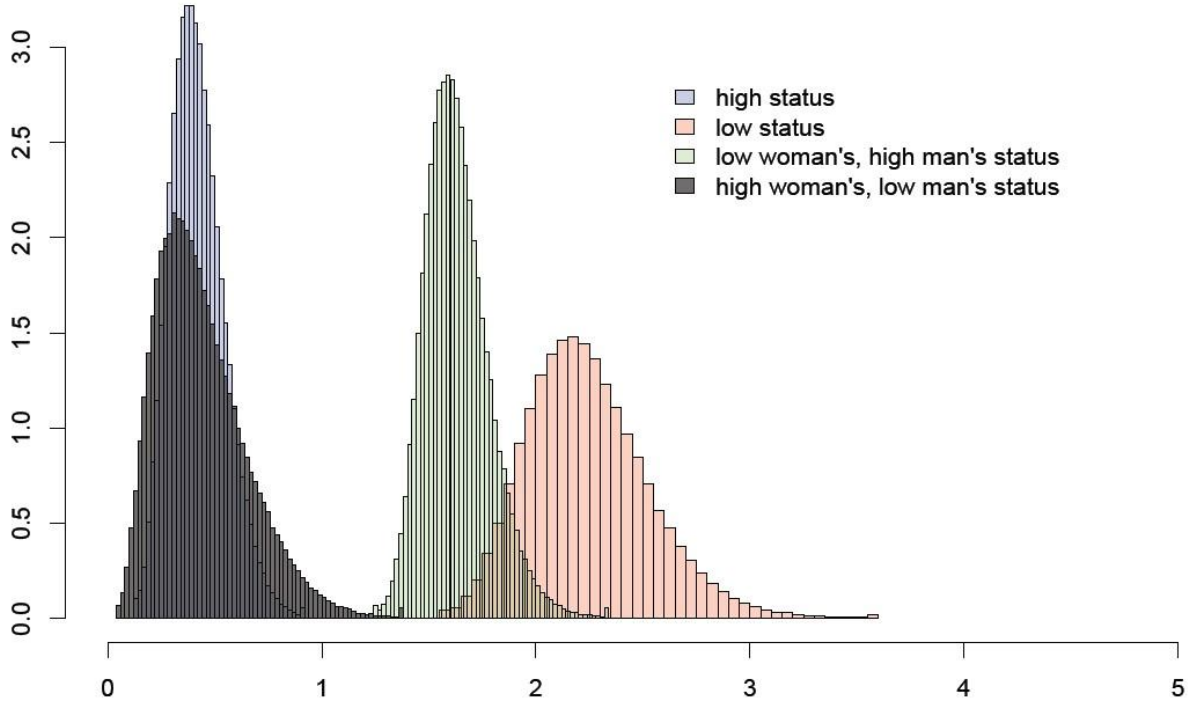
Fertility by couples' profiles

Bayesian approach allows us to analyze the fertility of couple's profile in a wider perspective and, what is the most important in this research, helps clarify the obtained relations between socioeconomic status and fertility in all analyzed dimensions (e.g., total fertility by socioeconomic status of a couple, probability of childlessness by couple's socioeconomic status, etc.). In this paper, the posterior distributions of expected (mean) number of children by couple's profile (so the total fertility by socioeconomic status of a couple) are presented. Four couple's profiles are distinguished: two of them show the differences between hyper- and hypogamous couples (hypergamous – low woman's and high man's SES; hypogamous – high woman's and low man's SES), and other two compare couples with high and low status.

The posterior distributions of expected number of children by couple's profiles in Austria are presented in Figure 8. The least fertile, as compared to the others, are two profiles: a couple with high status and a hypergamous couple. However, the posterior distribution for the latter profile is skewed to the right - it suggests that men with lower socioeconomic status than their partners more often contribute to the higher fertility than high status males. It seems, that, indeed as we expected, the gender roles start changing and men with low status could try to increase their attractiveness by giving some support in the daily duties and could start being more involved in the process of raising children.

The other interesting thing is that still the fertility in Austria seems to be more sensitive on the level of socioeconomic status of a couple that on the distribution of that status between partners (however the second dimension is important as well!). The highest number of children is expected among couples with low socioeconomic status, the lowest for couples with high status, while hypergamous and hypogamous couples are somewhere between.

Figure 8. The posterior distributions of expected number of children by couple's profiles in Austria

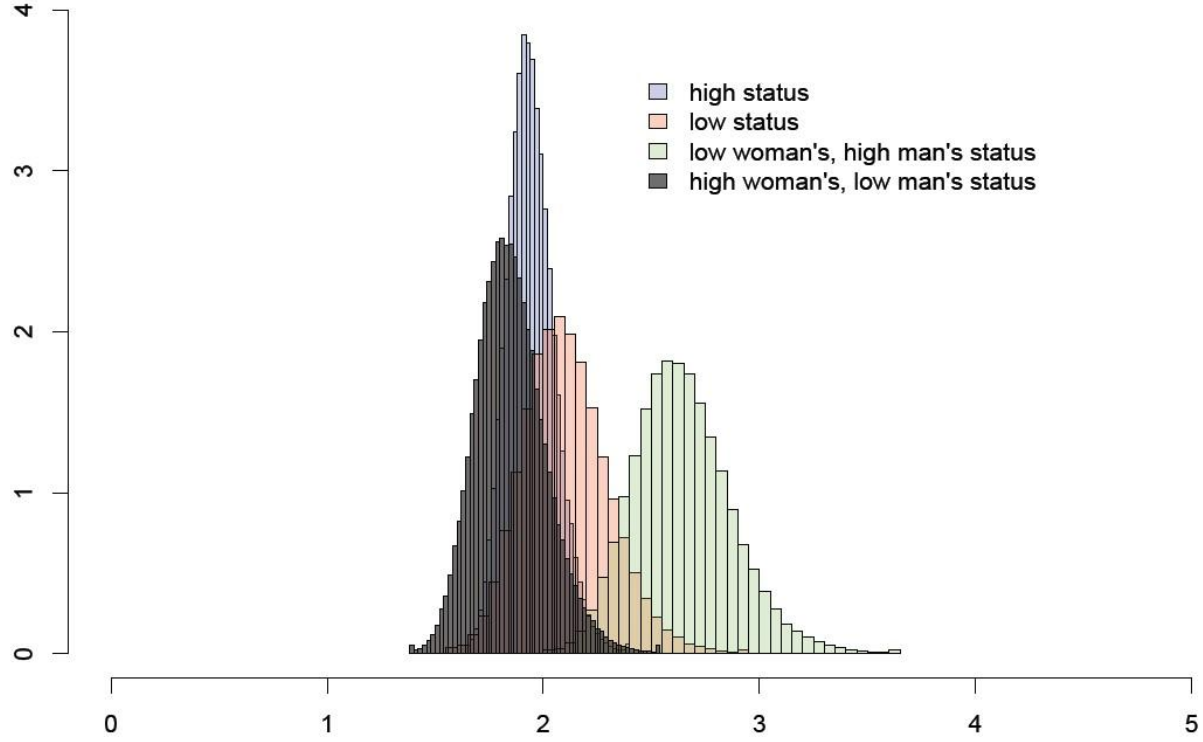


Source: Author's own elaboration

In France, on the other hand, different connections are visible – the corresponding posterior distributions are presented in Figure 9. The least fertile seems to be the hypogamous couple, while the highest fertility is expected for hypergamous partners. The distributions for low and high status couples lie somewhere between. Is suggests that, in contrast to Austria, in France the share of socioeconomic status between partners (hypogamous-hypergamous dimension) is more important for determining the fertility of a couple than the level of socioeconomic status (low-high status dimension). French men with lower s-e status than their partners visibly are not prone to take females roles in a family (the distribution for hypogamous couples is symmetric). In France, still the traditional (hypergamous) family model is the most conducive to maintaining big family.

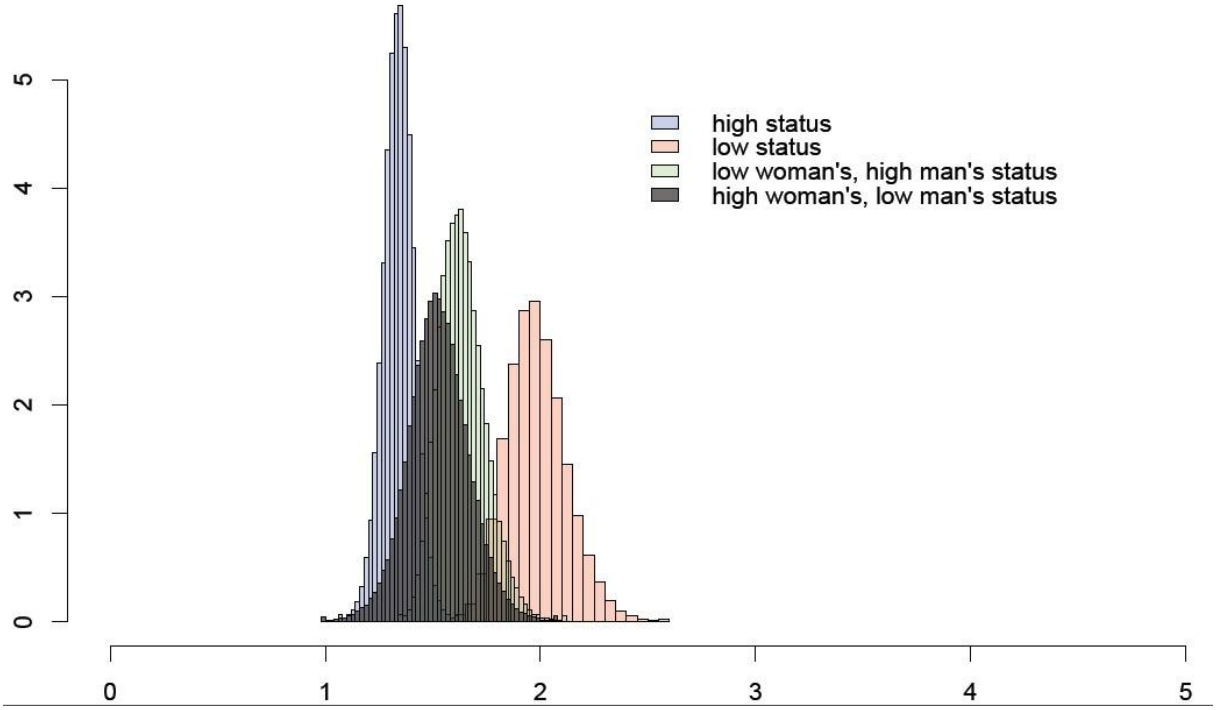
Finally, the posterior distributions of expected number of children by couple's profiles in Bulgaria are shown in Figure 10. Similar to Austria, the highest fertility is expected among couples with low socioeconomic status, while the lowest is expected for those with high status. Again, the distributions for hyper- and hypogamous couples lie somewhere between, which suggests that the level of socioeconomic status is more decisive for fertility in Bulgaria than the division of the status between partners. However, while in Austria the distribution of socioeconomic status between partners was still very important for fertility, in Bulgaria the influence of that dimension seems to be weaker and only small differences between fertility among hypergamous and hypogamous couples are expected. Additionally, we can observe that, similarly to France, men with lower status than their partners, , do not contribute to the higher fertility (symmetric distribution for hypogamous couple).

Figure 9. The posterior distributions of expected number of children by couple's profiles in France



Source: Author's own elaboration

Figure 10. The posterior distributions of expected number of children by couple's profiles in Bulgaria



Source: Author's own elaboration

V. CONCLUSIONS

The posterior results obtained for Austria, France and Bulgaria allowed to confirm the validity of distinction between two separate states in fertility analysis: childlessness and parenthood. The probability of these states appeared to be dependent on the socioeconomic status of a woman and a man in a couple, however, clear differences in the strength and direction of the impact of considered determinants are visible within these two states. What is more, based on the results it can be concluded that the impact of couple's socioeconomic status on the family model vary within the analyzed countries.

From the methodological point of view, the obtained results confirmed that the ZIP model compared to the standard Poisson regression model explains the contemporary reproductive behaviors much better. Based on a data sample for Austria it was shown that the ZIP model is 10^{64} times more probable than standard model.

The results presented in this paper are promising and encouraging for deeper studies on the impact of gender socioeconomic equality on fertility. Further analysis are carried out to deeply explore revealed connections from the "gender socioeconomic equality" perspective and to understand better the compromise concerning couple's family model due to gender equality between partners' socioeconomic status.

REFERENCES

1. Barthold J. A., Myrskylä M., Jones O. R. (2012). Childlessness drives the sex difference in the association between income and reproductive success of modern Europeans. Evolution and Human Behavior, nr 33, str. 628-638.
2. Baudin, T. & De La Croix, D. & Gobbi, P. (2012). DINKs, DEWKs & Co. Marriage, fertility and childlessness in the United States, CORE Discussion Papers 2012051, Université catholique de Louvain, Center for Operations Research and Econometrics.
3. Becker G. S. (1960). An Economic Analysis of Fertility [w:] Demographic and Economic Change in Developed Countries, Universities—National Bureau Committee for Economic Research Conference Series 11. Princeton, Princeton University Press, str. 209-231.
4. Becker G. S. (1991). A Treatise on the Family. Harvard College, Cambridge.
5. Cooke, L.P. 2009. Gender equity and fertility in Italy and Spain. *Journal of Social Policy* 38(1): 123-140.
6. Cronk, L. (1991). Wealth, status and reproductive success among the Mukogodo of Kenya. American Anthropologist, nr 93, str. 345–360.
7. Fieder M., Huber S., Bookstein F. L., Iber K., Schäfer K., Winckler G. (2005). Status and reproduction in humans: new evidence for the validity of evolutionary explanations on basis of a university sample. Ethology, nr 111, str. 940–950.
8. Fieder M., Huber S. (2007). The effects of sex and childlessness on the association between status and reproductive output in modern society. Evolution and Human Behavior, nr 28, str. 392–398.
9. Gurven M., von Rueden C. (2006). Hunting, social status and biological fitness. Biodemography and Social Biology, nr 53, str. 81–99.
10. Hobcroft R. L. (2006). Sex, status, and reproductive success in the contemporary United States. Evolution and Human Behavior, nr 27, str. 104–120.
11. Lambert D. (1992). Zero-Inflated Poisson Regression, with an Application to Defects in Manufacturing. echnometrics, Vol. 34, No. 1, pp. 1-14.

12. Lesthaeghe R., Moors G. (1996). Living Arrangements, Social Economic Position, and Values Among Young Adult: A Pattern Description for France, West Germany, Belgium and Netherlands, 1990, [w]: D. Coleman (red.), Europe's Population in the 1990s, Oxford University Press, pp. 163-221.
13. Lesthaeghe R. (1983). A Century of Demographic and Cultural Change in Western Europe: An Exploration of Underlying Dimensions. Population and Development Review, No. 9, pp. 411-435.
14. Matysiak A., Vignoli, D. (2013). Diverse effects of women's employment on fertility: insights from Italy and Poland. European Journal of Population, 29: 273-302.
15. McDonald P. (2000a). Gender equity, social institutions and the future of fertility. Journal of Population Research, No. 17, pp. 1-16.
16. McDonald P. (2000b). Gender equity in theories of fertility transition. Population and Development Review, Vol. 26, pp. 427-439.
17. McDonald P. (2006). Low fertility and the state: The efficacy of policy. Population and Development Review, Vol. 32(3), pp. 485-510.
18. Mynarska M., Matysiak, A. (2010). Diffusion of Cohabitation in Poland. Studia Demograficzne 157/158: 11-25.
19. Mynarska M. (2010). Deadline for Parenthood: Fertility Postponement and Age Norms in Poland. European Journal of Population, 26(3): 351-373.
20. Nettle D., Pollet T. V. (2008). Natural selection on male wealth in humans. The American Naturalist, No. 172, pp. 658–666.
21. Pflaumer P. (1988). Confidence Intervals for Population Projections Based on Monte Carlo Methods,. International Journal of Forecasting, No. 4, pp. 135-142.
22. Skirbekk V. (2008). Fertility trends by social status. Demographic Research, Vol. 18, str. 145–180.
23. Torr, B.M. and S.E. Short. 2004. Second births and the second shift: a research note on gender equity and fertility. *Population and Development Review* 30(1): 109-130.
24. Von Rueden C., Gurven M., Kaplan H. (2011). Why do men seek status? Fitness payoffs to dominance and prestige. Proceedings of The Royal Society of London B: Biological Sciences, nr 278, str. 2223–2232.
25. Weeden J., Abrams M. J., Green M. C., Sabini J. (2006). Do highstatus people really have fewer children? Human Nature, nr 17, str. 377–392.
26. Van Bavel, J. (2012). The Reversal of Gender Inequality in Education, Union Formation and Fertility in Europe. Vienna Yearbook of Population Research, 10, 127–154. doi:10.1553/populationyearbook2012s127
27. Van de Kaa D. J. (1987). Europe's Second Demographic Transition. Population Bulletin, Vol. 42, No 1, pp. 3–24.
28. Van de Kaa D. J. (1997). Options and sequences: Europe's demographic patterns. Journal of the Australian Population Association, Vol. 14, No 1, pp. 1-30.
29. Van de Kaa D. J. (1999). Europe and its population: the long view [w:] van de Kaa D. J., Leridon H., Gesano G., Okólski M. European Populations: Unity in Diversity, Kluwer Academic Publishers, Dordrecht.

APPENDIX A - METHODOLOGY

Bayesian inference in ZIP models

Bayesian methods in demography are relatively rarely used, thus the opportunities they give are still not entirely familiarized. Bayesian analysis is often the only approach that allows researchers to obtain detailed analysis of the phenomenon in case of a small amount of data or in a situation when it is necessary to make inferences about non-linear functions of model parameters. In addition, this approach provides simple tools for effective forecasting and enables us to obtain covariates and their function distributions, as well as allows us to incorporate our *a priori* knowledge (from previous studies or experts' beliefs). A more detailed outline of Bayesian inference can be found in Koop monograph (Koop 2003) and in studies of the applications of Bayesian methods in the field of financial econometrics (Zellner 1971, Bernardo and Smith 1994).

At first, the idea of Bayesian inference in demography was applied by Hyppola, Tunkelo, and Tornqvist, who applied a subjective approach to Finland population forecasting (Hypola et al. 1949). Due to the lack of computer power, which made Bayesian methods very laborious, the idea didn't spread among demographers at that point. But in 1986 and 1988, again the usefulness of Bayesian methods in demography was pointed out by Land and Pflaumer (Land 1986: 888-901, Pflaumer 1988: 135-142). Their studies encouraged other researchers to use a Bayesian approach. The idea has gained new followers and the popularity of Bayesian analysis among demographers has begun to increase slowly (Raftery 1995, Daponte et al 1997: 1256-1267, Bijak and Wiśniowski 2010, Bijak 2011, Bryant and Graham 2011, Raftery et al. 2012: 13915–13921, Bryant and Graham 2013).

Let us denote by $p(\theta)$ the prior knowledge about all unknown parameters. Posterior distribution is then formed from the *a priori* distribution and likelihood function of the model. In our study, the *a posteriori* distribution has the form presented below:

$$p(\theta|y) \propto L(\theta;y)p(\theta) = \left[\prod_{y_i=0} p_i \prod_{y_i>0} \left(\frac{(1-p)}{(1-\exp(-\lambda_i))} \exp(-\lambda_i)\frac{\lambda_i^{y_i}}{y_i!}\right)\right] f_N^{\gamma} f_N^{\delta} \quad (1)$$

where f_N^{γ} and f_N^{δ} are density functions for correspondent *a priori* distributions of γ and δ parameters.

Due to the unknown form of the posterior distribution[6], which is multidimensional, non-linear and too complicated to perform direct integration to determine its main characteristics, the Metropolis and Hastings (MH) algorithm was used. The procedure enables us to draw from the *a posteriori* distribution even when its form is analytically complicated.

[6] Although the analytical form of posterior distribution is given by (3), still we are not able to "recognize" any known distribution with given (defined) characteristics. The formula in (3) is also too complicated to calculate directly the characteristics of the posterior distribution.

The idea of the Metropolis and Hastings algorithm is to use some known, non-negative function $q(\theta^*;\theta^{(i-1)})$, called the proposal density, to generate a candidate state. Generally, the MH procedure consists of four subsequent steps [compare Geweke 1996, Robert and Casella 2005]:

1. Set up the initial point $\theta^{(0)}$ (it could be chosen arbitrary) and i=1.
2. Generate θ^* from the proposal density $q(\theta^*;\theta^{(i-1)})$ and u from the unitary distribution $U(0,1)$.
3. Check if the condition $\alpha(\theta^*,\theta^{(i-1)}) \geq u$ is fulfilled. If yes, set up $\theta^{(i)}=\theta^*$, otherwise $\theta^{(i)}=\theta^{(i-1)}$. The $\alpha(\theta^*,\theta^{(i-1)})$, called the acceptance probability, has the following form:

$$\alpha(\theta^*,\theta^{(i-1)})=\min\left\{\frac{\pi(\theta^*|y)\cdot q(\theta^{(i-1)};\theta^*)}{\pi(\theta^{(i-1)}|y)\cdot q(\theta^*;\theta^{(i-1)})},1\right\}, \quad (2)$$

where $\pi(\theta|y)$ is the kernel of the *posterior* density $p(\theta|y)$, so $\pi(\theta|y)\propto p(\theta|y)$. When $q(\theta^*,\theta^{(i-1)})$ is a symmetric function of θ^* and $\theta^{(i-1)}$, the formula (4) can be rewritten as:

$$\alpha(\theta^*,\theta^{(i-1)})=\min\left\{\frac{\pi(\theta^*|y)}{\pi(\theta^{(i-1)}|y)},1\right\}. \quad (3)$$

4. Set up i=i+1 and repeat point 2 and 3 M times.

From a certain cycle i, the sample $(\theta^{(i)},\theta^{(i+1)},..)$ can be treated as a draw from the *posterior* distribution [Geweke 1996].

In this study we set up the proposal density for each MH step as the multivariate t-Student distribution with 4 degrees of freedom, that is:

$$q(\theta^*;\theta^{(i-1)})=f_{St}^{k}(\theta^{(i-1)},\Sigma,4), \quad (4)$$

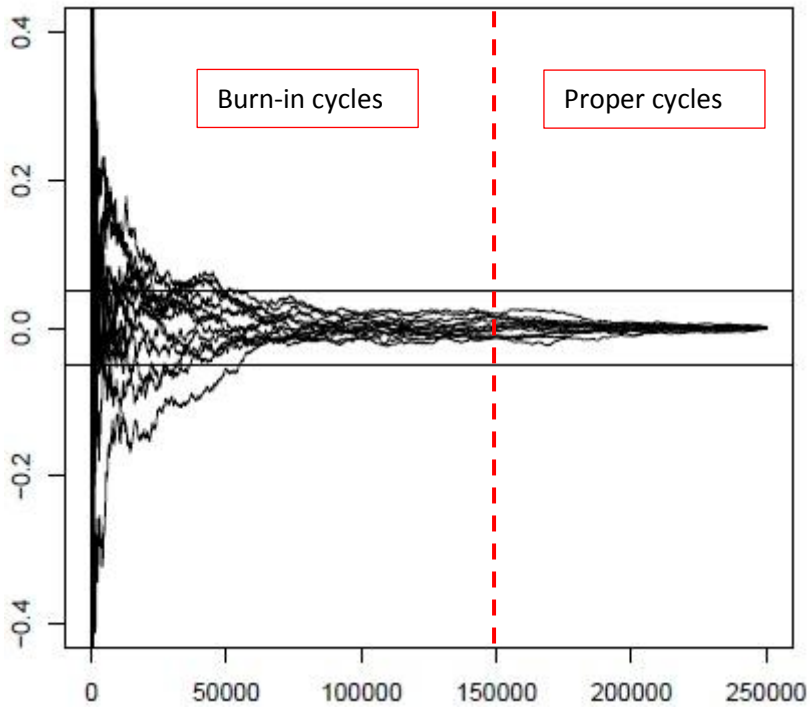
where k is the number of parameters in the zero or count states and Σ is an appropriately selected variance and covariance matrix. The choice of matrix depends on the researcher's preferences. This matrix is selected both to imitate in the best possible way the *a posteriori* distribution and to maintain the acceptance ratio at a reasonable level.

The problem presented in this study needed 100 000 initial cycles of the Metropolis and Hastings procedure (to "forget" the initial point, which usually is arbitrary chosen), then 150 000 burn-in cycles (to ensure convergence) and finally, 100 000 "proper" cycles considered as a (pseudo) random sample from the *a posteriori* distribution.

This number of burn-in cycles turned out to be sufficient to achieve convergence of the Metropolis and Hastings algorithm regarding to the CUSUM statistics proposed by Yu and Mykland (Yu and Mykland 1994). Therefore, the final sample can be treated as draws from the stationary distribution. That is why in the next step

the final cycles were used to determine marginal *a posteriori* distributions of $\gamma_1,\ldots,\gamma_s$ and $\delta_1,\ldots,\delta_r$ and calculate basic characteristics of the *a posteriori* distributions (expected value and standard deviation).

Figure 1. The convergence of CUSUM statistics for the MH algorithm



Prior model assumptions

The ZIP model is based on γ and δ parameters (with dimensions *s* for the zero state and *r* for count) for which the following *a priori* distributions were chosen:

$$\gamma \sim MVN(0_{[sx1]}, I_{[sxs]}) \quad (1)$$

$$\delta \sim MVN(0_{[rx1]}, 0.05 I_{[rxr]}) \quad (2)$$

The hyperparameters of the *a priori* distributions were chosen to both enable all possible values and remain coherent with the common knowledge in the case of a hypothetical woman. It has to be emphasized that in fertility analyses of contemporary populations, the prior distribution should set higher probabilities for smaller numbers of children (from zero to 3) and at the same time very low probabilities (even equal zero) for numbers of children bigger than 15.

Let *x* be a covariate vector representing features of a chosen couple. Then, based on 10 000 draws from priors of γ and δ parameters, μ and λ distributions for the chosen respondent were determined (Figure 2). The prior distribution of μ gives higher probabilities for values close to 0 or close to 1 (U-shaped). This U-shaped distribution is desirable – we would like to be as sure as possible to determine whether a couple with chosen characteristics is childless (μ close to 1) or not (μ close to 0).

The prior distribution of λ assumes that the smaller average numbers of children for chosen couple are more probable that the higher one (with the mean around 2-3 children).

Subsequently, we specified the *a priori* distribution of total number of children for the chosen couple (assuming prior distributions of p and λ as previously). Results are presented in Figure 3. As we can see, the distribution of number of children assigns non-zero probability for all expected *a priori* values, therefore it seems to be a reasonable expression of our initial knowledge about the analyzed variable before looking into the data.

Figure 2. The p and λ distributions (densities) for a selected couple

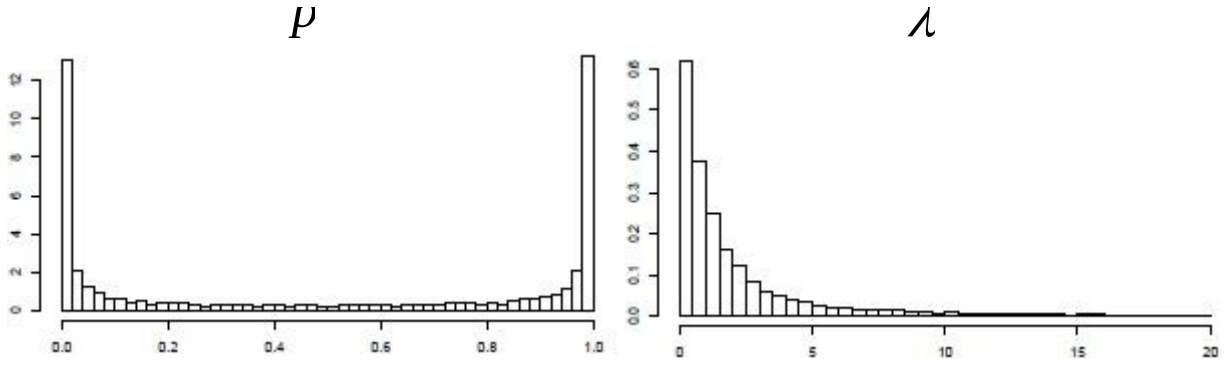
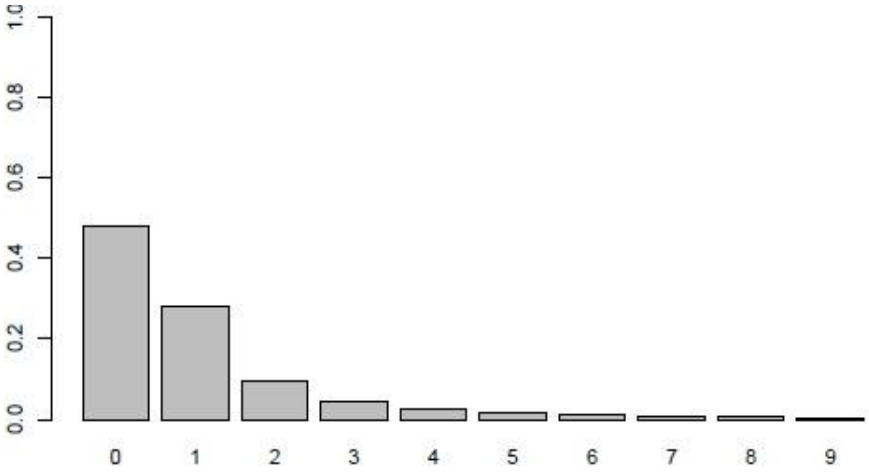


Figure 3. The prior distribution (density) of number of children for a selected couple



Literature

Bernardo J. M., Smith A. F. M., 1994, Bayesian Theory, J. Wiley, Chichester.

Bijak J., Wiśniowski A. (2010). Bayesian forecasting of immigration to selected European countries by using expert knowledge. Journal of the Royal Statistical Society, Series A, Statistics in Society.

Bijak J. (2011). Forecasting International Migration in Europe. A Bayesian View. Springer Series on Demographic Methods and Population Analysis, Vol. 24.

Bryant J., Graham P. (2013). Bayesian Demographic Accounts: Subnational Population Estimation Using Multiple Data Sources, Bayesian Analysis, 8(2): forthcoming.

Bryant J., Graham P. (2011). Demographic Estimates and Projections Using Multiple Data Sources: A Bayesian Approach, ISI, Dublin.

Daponte B. O., Kadane J. B., Wolfson L. J. (1997). Bayesian Demography: Projecting the Iraqi Kurdish Population, 1977-1990. Journal of the American Statistical Association, Vol. 92, No. 440, p. 1256-1267.

Geweke J. (1996). Monte Carlo Simulation and Numerical Integration [w:] H. Amman, D. Kendrick, J. Rust (red.), Handbook of Computational Economics. North-Holland, Amsterdam.

Hyppölä J., Tunkelo A., Törnqvist L. (1949). Suomen väestöä, sen uusiutumista ja tulevaa kehitystä koskevia laskelmia [Calculations Concerning the Population of Finland, Its Renewal and Future Development], "Tilastollisia tiedonantoja", 38. Helsinki: Statistics Finland.

Koop G. (2003). Bayesian Econometrics, Wiley, Chichester.

Land K. C. (1986). Methods for National Population Forecasts: A Review. Journal of the American Statistical Association, No. 81, pp. 888-901.

Raftery A.E., Li N., Ševčíková H., Gerland P., Heilig G.K. (2012). Bayesian probabilistic population projections for all countries. Proceedings of the National Academy of Sciences USA, 109(35): 13915– 13921.

Raftery A. E. (1995). Bayesian Model Selection in Social Research. Sociological Methodology, No. 25, pp. 111–163.

Robert C. P., Casella G., 2005, Monte Carlo. Statistical Methods, Springer, New York.

Yu B., Mykland P., 1994, Looking at Markov Samplers Through Cusum Path Plots: A Simple Diagnostic Idea, Technical Report No. 413, Department of Statistics, University of California at Berkeley.

Zellner A., 1971, An Introduction to Bayesian Inference in Econometrics, John Wiley, New York.

APPENDIX B – THE STRUCTURE

Number of children ever born

	[,1]	[,2]	[,3]	[,4]	[,5]	[,6]
AT	0.187	0.243	0.372	0.142	0.042	0.014
BG	0.059	0.381	0.498	0.047	0.010	0.006
FR	0.188	0.217	0.422	0.148	0.019	0.007

Education - women

	[,1]	[,2]	[,3]
AT	0.1405855	0.6816046	0.1778099
BG	0.1772824	0.5541401	0.2685775
FR	0.2555737	0.3143013	0.4301251

Education - men

	[,1]	[,2]	[,3]
AT	0.07408746	0.6917239	0.2341887
BG	0.17515924	0.6581741	0.1666667
FR	0.21859706	0.4497009	0.3317020

Income - Austria

	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-4.0	4.0+
Women	0.194	0.317	0.297	0.118	0.044	0.014	0.013	0.003
Men	0.018	0.045	0.256	0.310	0.201	0.068	0.078	0.023

Income - Bulgaria

	0-26	26-61	61-102	102-154	154-205	205-307	307-409	409+
Women	0.144	0.226	0.325	0.206	0.054	0.026	0.006	0.013
Men	0.036	0.120	0.254	0.275	0.157	0.109	0.019	0.030

Income - France

	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-4.0	4.0+
Women	0.090	0.270	0.362	0.162	0.065	0.021	0.022	0.008
Men	0.014	0.057	0.398	0.256	0.121	0.053	0.074	0.029

Activity Status - women

	Not Active	Unemployed	Other
AT	0.23780267	0.03505602	0.7271413
BG	0.02476999	0.17374381	0.8014862
FR	0.10875476	0.06144644	0.8297988

Activity Status - men

	[Not Active]	[Unemployed]	[Other]
AT	0.002529816	0.02493675	0.9725334
BG	0.000000000	0.11748054	0.8825195
FR	0.003262643	0.03806417	0.9586732

APPENDIX C – THE POSTERIOR RESULTS

AUSTRIA

Figure 1. The marginal posterior distributions for Austria – the zero model

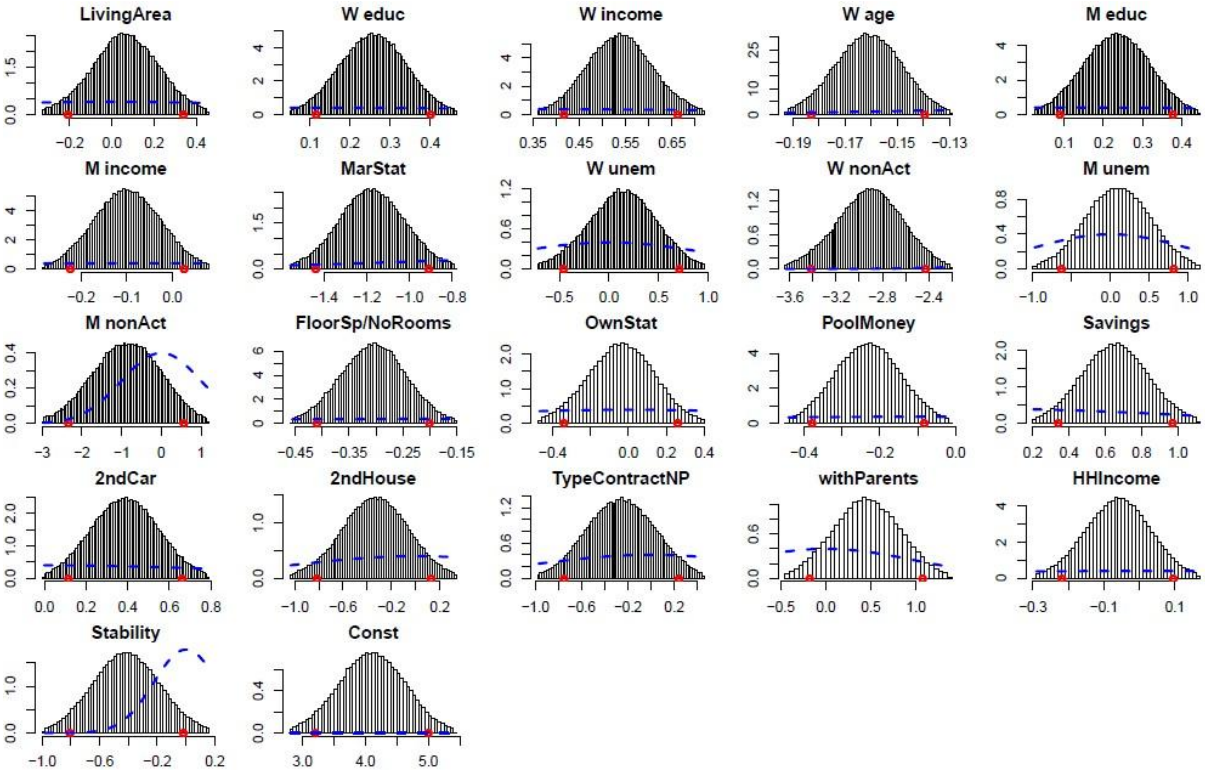
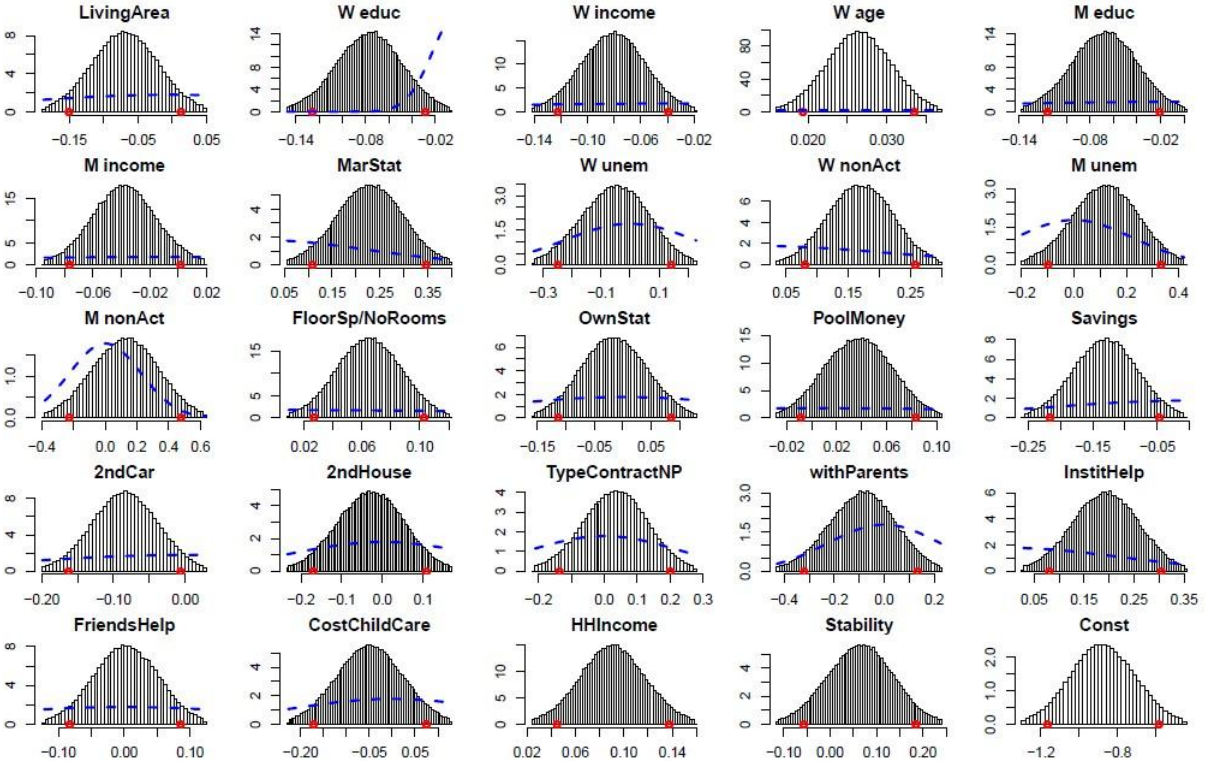


Figure 2. The marginal posterior distributions for Austria – the count model



BULGARIA

Figure 3. The marginal posterior distributions for Bulgaria – the zero model

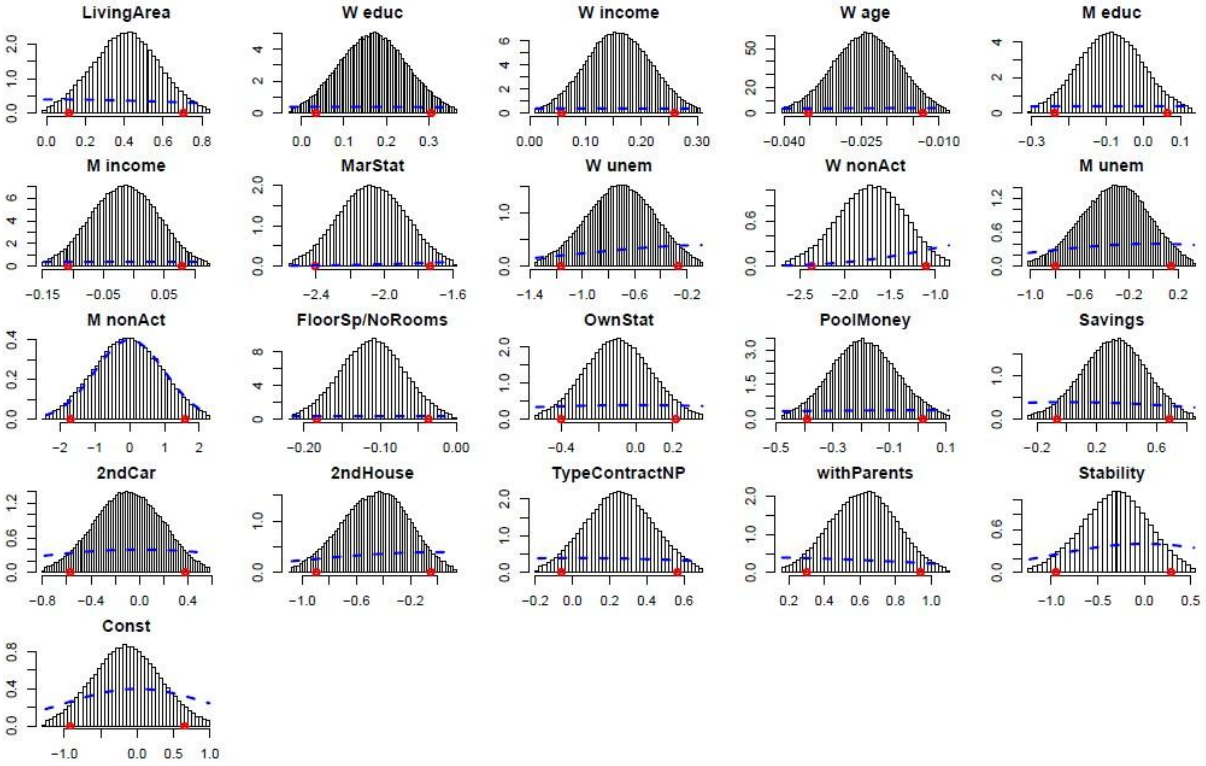
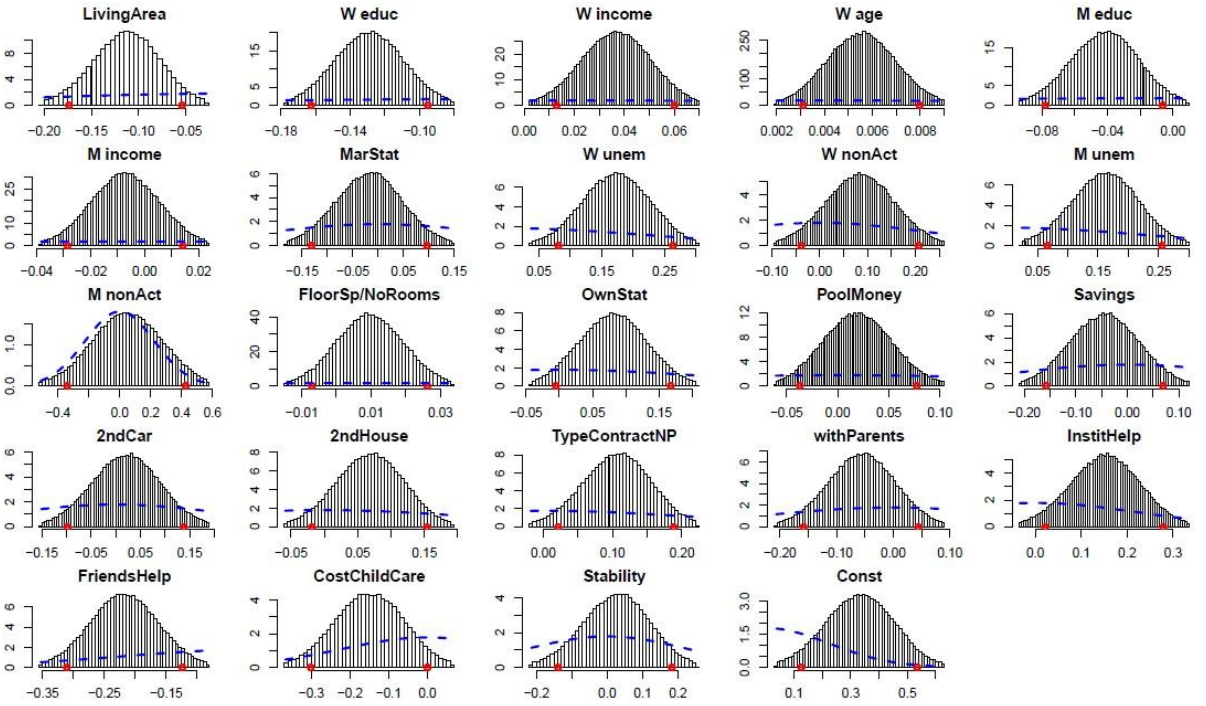


Figure 4. The marginal posterior distributions for Bulgaria – the count model



FRANCE

Figure 5. The marginal posterior distributions for France – the zero model

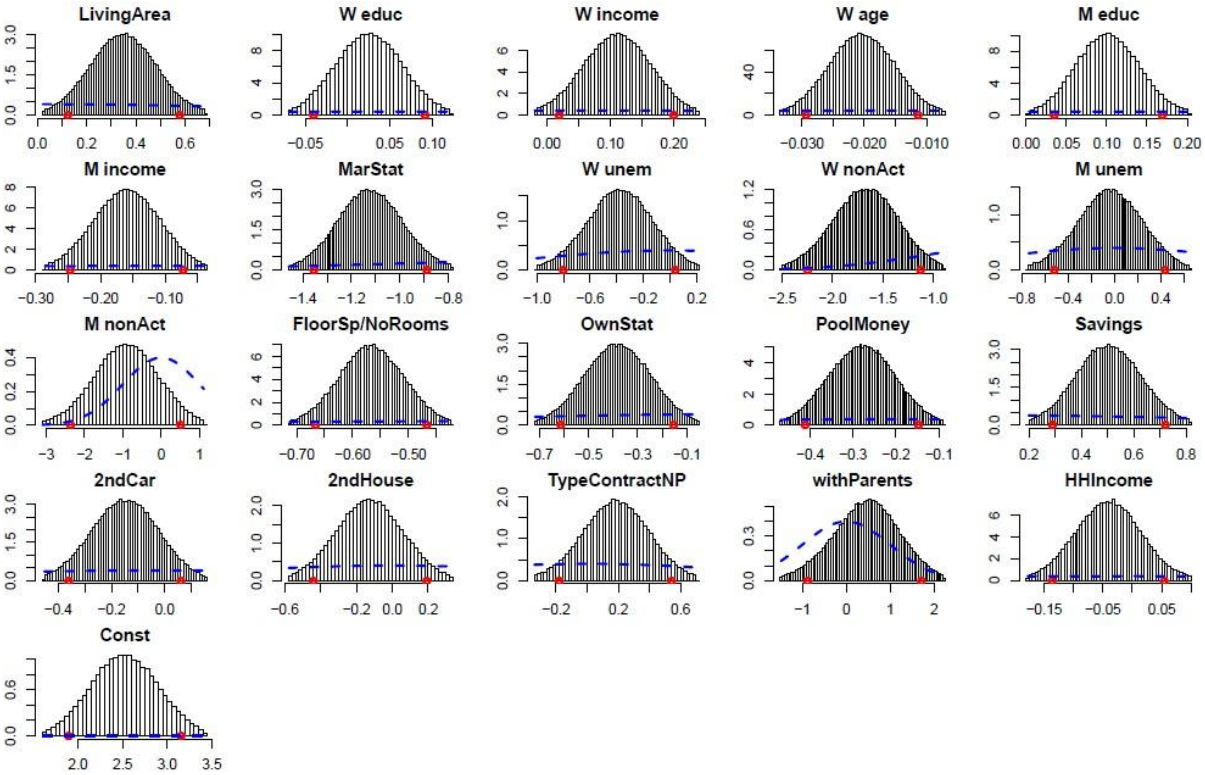


Figure 6. The marginal posterior distributions for France – the count model