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Modelling the perception of conflict in working conditions

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Unfavourable working conditions are a relevant and sensitive issue in the field of economic and social studies. The topic has been deeply investigated, especially in order to build intrinsic job quality indices. More recently, several psycho-social risks that negatively impact on workers' health and well-being, such as very high work intensity and perception of conflict with personal values on the job, have become prominent matters of interest. However, very little is known about the measure of value/beliefs contrasts at work as indicator of poor working conditions. We discuss a class of statistical models able to measure the experience of conflict between personal and organizational ethics in a large sample of respondents. By means of these models, our proposal enhances the different contributions of subjects' covariates in the response pattern. The starting point of the approach is a mixture model to interpret the ordered level of perception as a blend of real beliefs and indecision. Those two unobserved components are easily parameterized and immediately related to subject' covariates. Empirical evidence is provided by the 5^{th} European Working Condition Survey carried out by Eurofound in 2010.

keywords: Working conditions, Ordinal data, CUB models.

1 Introduction

Work plays an important role in people's life and for companies and society at large. Measuring working conditions is one of the main objectives of the labour market surveys, aiming at identifying which work situations and which groups of workers and occupations

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face special difficulties, so to address suitable policy issues. Past research has shown a positive link between the enhancement of personal values at work and the organizational engagement (Saks *et al.*, 1996). Conversely, workers who strongly stick to their own ethics are considered less capable to effectively cope with work-related stress (Olsen *et al.*, 2010). The current European debate on job quality, working life sustainability and their perception emphasizes the European objectives towards "more and better jobs" (European Commission, 2010). Job quality indices would be expected to be associated, individually and collectively, with well-being at work, as well as with other intangible goods that are a relevant issue in the approach promoted by the Commission on the Measurement of Economic Performance and Social Progress (Stiglitz *et al.*, 2009). In particular, scholars are interested in discovering the main aspects that affect the self-assessed evaluation of workers' conditions (Clark, 2001). In such psychological and sociological surveys, where ordinal options have to be selected, some of the relevant items manifest a wide proportion of uncertainty in the responses due to a number of reasons: significative/sensible and discomfit questions, inaccurate or vague wording, inadequate notion of the issue, etc. Therefore, it is highly probable that the frequency distribution of the responses shows a specific category as the preferred one: a kind of "refuge" category selected by the interviewee, defined *shelter effect* (Iannario, 2012a).

We focus on a class of models generated by a discrete probability distribution which takes into account two latent components pertaining to the response, and denoted as feeling and uncertainty, for simplicity. In particular, we analyze the perception of the conflict with personal values in working conditions self-assessment, using data stemming from the 5^{th} European Working Conditions Survey (EWCS), carried out between January and June 2010 by Eurofound, the European Foundation for the Improvement of Living and Working Conditions. Respondents of dataset of interest are about $36,000$ workers proportionally shared among countries with a rough ratio with inhabitants. The questionnaire covers several issues including precarious employment, leadership styles, worker participation and representation, as well as general job context, working time, organization, salary, health risks' perception, work-life balance, psychosocial factors, and so on.

The analysis is focused on the study of the perception of *conflict* with personal (ethical) values at work, referred to a subset of respondents' covariates such as age, age at ending studies and number of family members.

The paper is organized as follows: in the next section the model chosen for the statistical analysis is motivated and presented. In section 3 data set is described and main results are presented. Some concluding remarks end the paper.

2 A simplified model for ordinal responses

The analysis of ordinal variables usually relies on Generalized Linear Models (GLM) proposed by McCullagh (1980) and McCullagh and Nelder (1989) which explain the expected values of responses by means of a link with selected covariates. The most useful and simplest structure is the proportional odds models where the probability of

a response less or equal to a target r, say, is a logistic function of the subjects' covariates (Agresti, 2010; Tutz, 2012). This framework is well consolidated in the statistical literature and most of real applications refer to it.

In this paper, an alternative approach based on a mixture distribution and named as CUB model is motivated on the basis of two focal points:

- *Uncertainty.* In the classical framework the respondent's uncertainty is not explicitly taken into account and so the effect of the expected response masks this component. Instead, indecision in the response is considered and also related to respondents' covariates.
- *Interpretation.* Visualization of the estimated models and the effects of covariates are sharply depicted by several graphical devices and this generally conveys a simpler interpretation of the results.

Hereafter, we establish some essential notations to understand the core of these alternative methods. Thus, we introduce CUB models and then discuss their adequacy.

2.1 CUB models and extensions

Briefly, the response R, to a rating survey where ordinal responses are required, is a random variable defined over the support $\{1, 2, \ldots, m\}$, for a given m, whose probability mass distribution is:

$$P_r\left(R = r \mid \boldsymbol{\theta}\right) = \pi \binom{m-1}{r-1} \xi^{m-r} \left(1-\xi\right)^{r-1} + \left(1-\pi\right) \frac{1}{m}, \quad r = 1, 2, \ldots, m. \qquad (1)$$

The mixture is a convex *C*ombination of a discrete *U*niform and a shifted *B*inomial random variable, and this motivates the acronym CUB (Piccolo, 2003). Since (1) is well defined when $\pi \in (0, 1]$ and $\xi \in [0, 1]$, the parametric space is the (left open) unit square:

$$\Omega(\boldsymbol{\theta}) = \Omega(\pi, \xi) = \{(\pi, \xi) : \ 0 < \pi \leq 1; \ \ 0 \leq \xi \leq 1\}.$$

Iannario (2010) proved that CUB models are identifiable for any $m > 3$, whereas $m = 3$ implies a saturated model. We observe that $\pi \to 0$ implies a model with an almost totally uncertain selection of a category, whereas $\pi \to 1$ implies a drastic reduction of this component; then, $1 - \pi$ is related to the *uncertainty* of the selection. Similarly, assuming that the item is positively worded, when $\xi \to 0$ high values of the support are more likely whereas for $\xi \to 1$ the preferred selection of responses are on the low values of the support; then, $1-\xi$ is related to positive *feeling* (attraction, agreement, etc.) towards the item. In this way, both parameters may be interpreted since they summarize uncertainty and feeling of the respondents, respectively. In addition, since a CUB model is univocally defined by (π, ξ), each model is depicted in the unit square by means of a point with coordinates $(1 - \pi, 1 - \xi)$, which are immediately related to uncertainty and feeling, respectively. These circumstances establish a one-to-one correspondence between CUB models and those points. As a consequence, the effects of covariates on

the estimated models are immediately visualized and their effects may be discussed in terms of uncertainty and feeling.

Then, covariates are introduced in the model by a logistic link with the parameters π_i and ξ_i, which are now related to respondents' characteristics. More precisely, a CUB model with p covariates to explain uncertainty and q covariates to explain feeling is specified by:

1. A *stochastic component*:

$$Pr\left(R_i = r \mid \boldsymbol{y}_i;\, \boldsymbol{w}_i\right) = \pi_i \binom{m-1}{r-1} \xi_i^{m-r} (1-\xi_i)^{r-1} + (1-\pi_i)\left(\frac{1}{m}\right),$$

   for $r = 1, 2, \ldots, m$, and for any i-th subject, $i = 1, 2, \ldots, n$.

2. Two *systematic components*:

$$logit(\pi_i) = \boldsymbol{\beta}\boldsymbol{y}_i\,; \qquad logit(\xi_i) = \boldsymbol{\gamma}\boldsymbol{w}_i\,.$$

   where we denote $logit(z) = \log(z/(1-z))$ for any real $z \in (0,1)$ and $\boldsymbol{y}_i$ and $\boldsymbol{w}_i$ are the subjects' covariates for explaining π_i e ξ_i, respectively, for $i = 1, 2, \ldots, n$. For convenience, we set $y_{i0} = w_{i0} = 1, \forall i$ and $\boldsymbol{\beta} = (\beta_0, \beta_1, \ldots, \beta_p)'$, $\boldsymbol{\gamma} = (\gamma_0, \gamma_1, \ldots, \gamma_q)'$.

The logistic link has been preferred for its formal simplicity; however, any mapping from $\mathbb{R}$ to $(0,1)$ is a legitimate choice, as those generally advocated in the GLM approach: see Agresti (2010) for details. Notice that covariates $\boldsymbol{y}_i$ and $\boldsymbol{w}_i$ may be coincident, completely different or partially overlapping.

Given a sample of response $(r_1, r_2, \ldots, r_n)$ and the subjects' covariates $\boldsymbol{y}_i$ and $\boldsymbol{w}_i$, for $i = 1, 2, \ldots, n$, an asymptotically efficient procedure based on Maximum Likelihood methods and EM algorithm to select significant covariates and testing the estimated model have been derived (Piccolo, 2006) and a program in R is freely available (Iannario and Piccolo, 2014). It is worth saying that CUB models have been extended and generalized in several directions: to include objects' covariates (Piccolo and D'Elia, 2008), to take hierarchical effects into account (Iannario, 2012b), to include overdispersion (Iannario, 2014), to consider nonlinear transition probabilities (Manisera and Zuccolotto, 2014b), to take "don't know" responses into account (Manisera and Zuccolotto, 2014a), and so on. In any case, hereafter we limit ourselves to consider CUB models with subjects' covariates.

In a survey where an item is submitted with m ordinal categories, we assume that respondents adopt a strategy which is a weighted mixture of a CUB model and a definite choice over a refuge category. This assumption includes both the case where a proportion δ of respondents adopts a lazy strategy and the case where each respondent has a propensity to adhere to a *shelter* or a CUB model with weights δ and $1-\delta$, respectively.

In some circumstances people prefer to take refuge into a category which is interpreted as safe, neutral, indifferent, not demanding, etc. The consequence is that the selected category manifests a frequency greater than that expected according to the maintained model for the responses. This consideration requires some adjustment in the standard model to improve the fitting and interpretation of the respondents' behaviour and also to

reduce bias and increase efficiency of the estimates. These models have been called CUB models with a *shelter* effect and they include a dummy covariate to explain the mentioned atypical behaviour of a given category (Corduas *et al.*, 2009; Iannario, 2012a).

For a given $m > 4$ and $c \in \{1, 2, \ldots, m\}$, a CUB model with a *shelter effect* at $R = c$ is defined by:

$$Pr\left(R = r \mid \boldsymbol{\theta}\right) \;=\; \delta\, D_r^{(c)} \;+\; (1-\delta)\left[\pi\, b_r(\xi) + (1-\pi)\,\frac{1}{m}\right].$$

where $D_r^{(c)}$ is a degenerate random variable whose probability mass is concentrated at $r = c$, that is:

$$D_r^{(c)} = \begin{cases} 1, & \text{if } r = c; \\ \\ 0, & \text{otherwise.} \end{cases}$$

The parameter $\delta \in [0, 1]$ measures the importance of the *shelter* category.

Among the many representations of the *shelter effect*, we prefer to plot the estimated model as a point in the unit square and add a segment over this point which is proportional to the estimated δ. In this way, we exploit the same visualization for real data with and without the *shelter* effect.

2.2 Motivations for choosing CUB models

Within the EWCS questionnaire, with special reference to self-evaluated work situations as experienced by respondents, we select to deeply analyze the item Q51L of the questionnaire, a statement which asks to select the response which best describes one's work situation: "Your job imply tasks that are in conflict with your personal values". This is a sensitive and tricky question since it involves (or may involve) ethical and inward conditions, and emotions. In addition, this issue may interact with other perceived working conditions and also impact on job satisfaction, commitment, emotional involvement, absence at work, desire to change or quit the job, etc.

Among the several approaches to ordinal data modelling, we select CUB models for the following motivations. Questions of interest are related to the *perception of working conditions* and the level of agreement is expressed on $m = 5$ categories: "Never", "Seldom", "Sometimes", "Most of the time", "Always". The topic we discuss concerns the perception of performing tasks that contrast with respondents' personal values. Thus, the nature of the item itself and the possible categories strongly suggest the presence of both *feeling* and *uncertainty* in the responses. In this respect, CUB models allow to visualize both components by means of a simple graphical display obtained by efficient estimation methods. The significance of subjects' covariates on the given responses is easily verified with a unique approach for dichotomous, polytomous and continuous covariates. Moreover, if some relationship does exist between feeling and uncertainty, CUB models will detect it without imposing extra constraints in the model. Current software allows to compare several items in a single representation in order to emphasize similarities in the behaviour of the respondents. Assuming definite profiles of respondents, it

Table 1: Items of Q51 question

	Items	Original questionnaire statements
A	*coworkers*	Your colleagues help and support you
B	*boss*	Your manager helps and supports you
C	*involvement*	You are consulted before targets for your work are set
D	*commitment*	You are involved in improving the work organisation or work processes of your department or organisation
E	*haveasay*	You have a say in the choice of your working partners
F	*pause*	You can take a break when you wish
G	*time*	You have enough time to get the job done
H	*wellmade*	Your job gives you the feeling of work well done
I	*ideas*	You are able to apply your own ideas in your work
J	*usefulness*	You have the feeling of doing useful work
K	*expectation*	You know what is expected of you at work
L	*conflict*	Your job involves tasks that are in conflict with your personal values
M	*emotion*	You get emotionally involved in your work
N	*stress*	You experience stress in your work
O	*influence*	You can influence decisions that are important for your work
P	*hiding*	Your job requires that you hide your feelings

is immediate to show the whole probability distribution corresponding to such clusters. In the following, we denote feeling as the *agreement to the proposed statement* and we use the scale reversed to better display our results.

3 Data set characterization and modelling

As a European Union Agency, Eurofound provides information, advice and expertise as well on industrial relations and managing change in Europe for key actors in the field of EU social policy on the basis of comparative information, research and analysis. Every five years, Eurofound carries out the EWCS, interviewing both employees and self-employed people about their work and employment conditions. The aim of the survey is to compare working conditions across Europe so as to provide inputs for different stakeholders: European policymakers, employers' organisations, trade unions, governments of Member States and European institutions. The fifth EWCS has been conducted in the first half of 2010 in the following 34 countries: the EU27 Member States, plus Norway (a member of the European Free Trade Association), Croatia, the former Yugoslav Republic of Macedonia, Montenegro and Turkey (as candidate countries), Albania and Kosovo (as potential candidate countries).

The sample used in the EWCS is representative of those aged 15 years and over (16 and over in Spain, UK and Norway) who are in employment and resident in the country being surveyed. In each country, a multistage stratified random sampling design was

used. The target number of interviews was 1,000 in all countries except Slovenia (1,400), UK, Italy and Poland (each 1,500), Germany and Turkey (each 2,000), France (3,000) and Belgium (4,000). The Belgian, French and Slovenian governments decided to take up the option offered by Eurofound to pay for an addition to the initial sample size. The total number of the respondents reaches 37,000. The general response rate is 44%, the highest in Latvia (74%), followed by Bulgaria and Cyprus (66%), the lowest in Spain (31%).

The main topics covered in the questionnaire for the fifth EWCS are: job context, working time, work intensity, physical, cognitive and psychosocial factors, violence, harassment and discrimination, work organisation, prospects, social relationships, work-life balance and financial security, health and well-being. In designing the questionnaire, special attention was focused on the construction of gender-sensitive indicators. With reference to self-assessed perception of working conditions, in Question 51 respondents are asked to answer 16 specific items whose original statements are reported in Table 1.

A question introduced in the last edition of the survey is related to conflict perception. In general, about 9% of the whole sample declare that their work "Always" or "Most of the time" involves tasks that contrast with their personal values. This percentage varies not so much across sectors, though value conflicts seem to be prevalent in construction and less relevant in industry and education. In Figure 1 the observed relative frequencies of the responses to the selected item are shown. More than 60% of the sample answers "Never", whereas 8.6% of workers report a perception to perform stasks which "Most of the time" or "Always" struggle with their personal values.

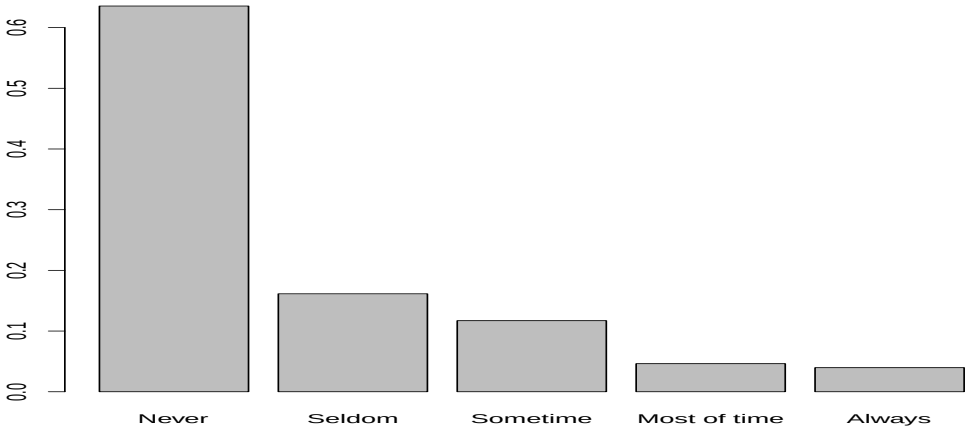

Figure 1: Frequency distribution of *conflict* between job and personal values

Table 2: Estimated CUB models for the response item *conflict*

CUB models	Uncertainty	Log-likelihood	N.param.	BIC
Without covariates	0.302	−39892.70	2	79799.39
With a *shelter effect*	0.357	−39586.38	3	79193.74
With selected covariates	0.294	−38246.12	7	76541.19

3.1 Some empirical evidence

As an instance of the potential of the approach implied by the family of CUB models we present a subset of the results to emphasize different aspects of data. More precisely, we show some empirical evidence with respect to a graphical display featuring a summary of CUB models with a *shelter effect* estimated for all the items included in the Question 51. Results related to the implementation of CUB models for all the statements with *shelter* effect at category $c = 1$ (that is "Never") are shown in Figure 2: three clusters of items are evident. The first one is characterized by a low level of uncertainty and a high agreement/feeling (*coworkers*, *expectation*, *wellmade*, *usefulness*, *time*). The second one depicts high level both of agreement and of uncertainty (*involvement*, *commitment*, *pause*, *ideas*, *emotion*, *influence*, *hiding*). The third one consists of *haveasay* –which is a clear outlier– whereas *conflict* and *stress* show an intermediate level of both parameters. Notice that the vertical lines drawn above the dots represent the magnitude of the *shelter effect* and this is quite remarkable for the items *conflict*, *have a say* and *hiding*.

The atypical behaviour of responses for the item denoted as *conflict* motivates further research using the CUB models.

3.2 A CUB model for the perception of *conflict*

We performed several estimations for *conflict* using different CUB model specifications. Main results are summarized in Table 2 and show a substantial uncertainty in the responses since $1 - \hat{\pi} = 0.302$. Indeed, all estimated models confirm that uncertainty is approximately evaluated around 0.30. The estimate of $1 - \hat{\xi} = 0.050$ confirms that most of the distribution is concentrated in the low values of the range. Moreover, the inclusion of a *shelter effect* sensibly improves the fit as confirmed by the log-likelihood values. Finally, BIC measures support that the inclusion of covariates is really effective.

In the left panel of Figure 3 we can see the observed frequencies and the fitted probabilities for a CUB model without covariates, whereas in the right panel the same model with a *shelter effect* is shown. It is evident a significantly improved fitting since the dissimilarity index decreases from 0.054 to 0.010 with just one added parameter.

However, to obtain a more useful interpretation of the responses, it is necessary to include subjects' covariates which significantly increase the log-likelihood of the model. This research requires an *ad hoc* stepwise procedure in the estimation of the models and we limit ourselves to present only the final results where $lage = \log(age) - \overline{\log(age)}$,

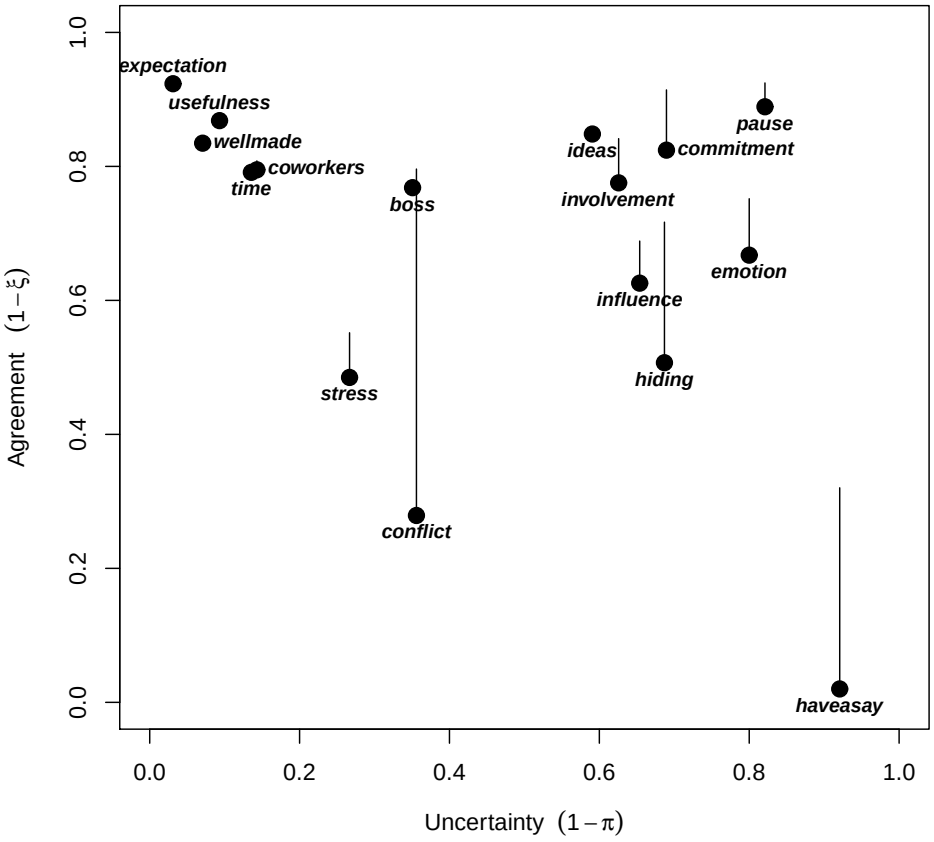

Figure 2: Estimated CUB models with a *shelter* effect for all items of Q51 question

and $\overline{\log(age)}$ is the average of logged age, *members* (=number of components of the family), *agestudy* (=age at ending studies) and *agestudy* × *lage* (=interaction of the covariates *agestudy* and *lage*) are significant. Although a gender-based literature does exist in business and cognitive sciences (Mason and Mudrack, 1996), no significant gender difference emerges in our analysis.

Thus, we interpret the effect of these covariates on the response by examining the function between the agreement with the perception of *conflict* (that is $1 - \xi_i$) and the single covariate. These relationships are graphically shown in Figure 4 with reference to the covariates *lage* (left panel), *members* (middle panel) and *agestudy* (right panel), respectively. It is evident that the agreement is asymmetrically U-shaped with respect to age and reaches its highest value at 34.81 years. In our analyses, indeed, it seems reasonable that the age of the respondent affects the assessment of ethical tensions

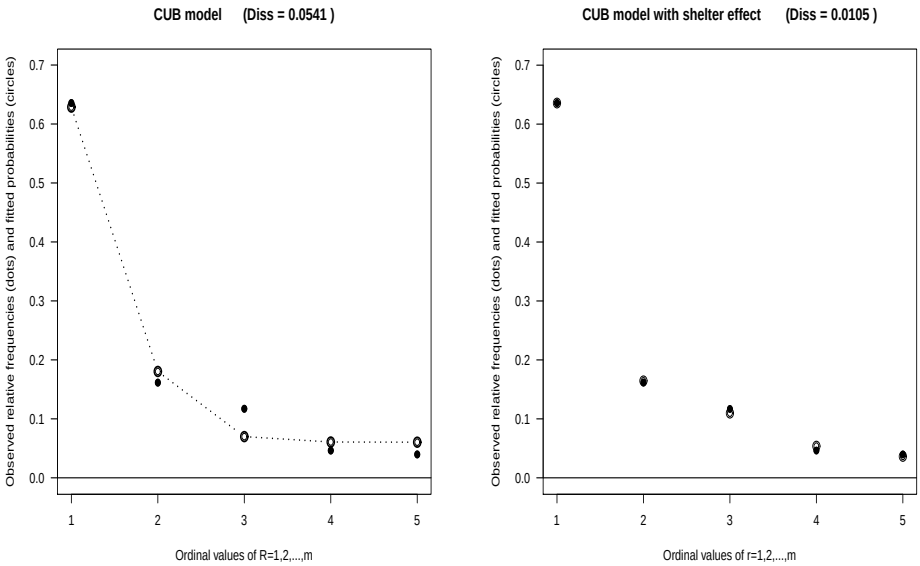

Figure 3: Item *conflict*: observed and estimated distributions of CUB models without (left panel) and with a *shelter effect* (right panel)

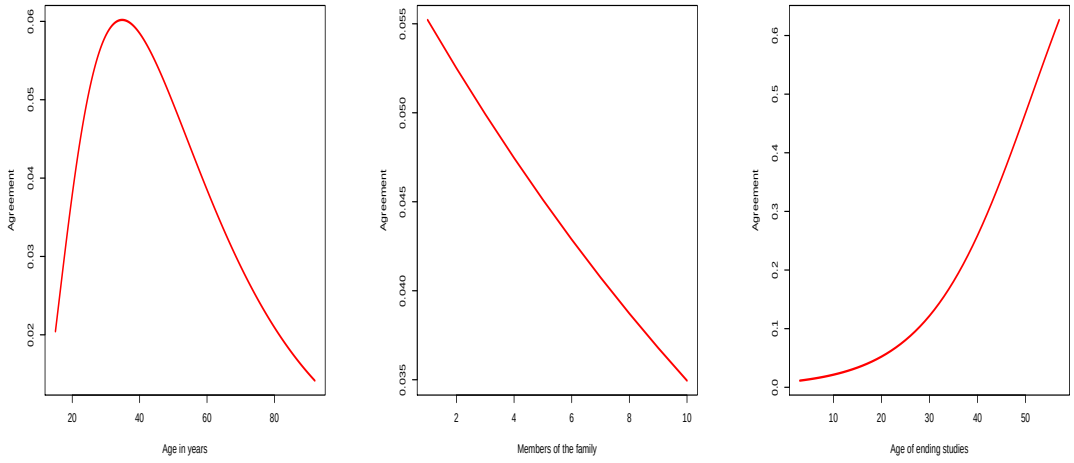

Figure 4: Relationship among the agreement towards *conflict* and age of respondent (left panel), number of members of the family (middle panel), and age at ending studies (right panel)

in working conditions, as elder people present a minor perception of conflict due to an hypothetically increased experience in coping with challenging events both at work and in everyday life. Moreover, the agreement decreases in a significant way when respondents belong to a large family: as a matter of fact, the perception of ethical conflicts declines as the number of family members arises. Finally, the agreement increases with the age at ending studies since more educated workers are likely to be more sensitive to moral and ethical issues.

Rebus sic stantibus, we look for an omnibus CUB model which includes the previous significant subjects' covariates and whose parameters are all statistically significant. Thus, the best model we obtained to explain the agreement with the perception of *conflict* is the following one:

- *Stochastic component*:

$$Pr(R_i = r \mid \hat{\boldsymbol{\theta}}) = \hat{\pi}_i \binom{4}{r-1} \hat{\xi}_i^{5-r} (1-\hat{\xi}_i)^{r-1} + (1-\hat{\pi}_i) \left(\frac{1}{5}\right),$$

  for $r = 1, 2, \ldots, 5$ and $i = 1, 2, \ldots, 35508$.

- *Systematic components*:

$$\begin{cases} 1-\hat{\pi}_i & = & 0.294\,; \\ logit\left(1-\hat{\xi}_i\right) & = & -4.441 + 0.830\, lage_i - 1.626\, lage_i^2 - 0.077\, members_i \\ & = & +0.095\, agestudy_i - 0.062\, agestudy_i \times lage_i; \end{cases}$$

Since the sign of the relationship in the omnibus model is preserved we can maintain the same interpretation of the covariates in terms of effects on the agreement. In addition, it is possible to build combined versions of the previous plots by considering together the values of the implied variables. Thus, we can see how the agreement is modified when age of the respondent, number of the family members and age at ending studies are simultaneously considered. In Figure 5 each panel is referred to the number of family members and we can observe the agreement as a function of age in years (abscissa) and age at ending studies, selected as $(16, 30, 40, 55)$, and depicted at the beginning of each line. The agreement decreases for respondents aged more than forty years; moreover, it decreases when the age at ending studies lowers and the number of components of the family raises. Finally, observe that uncertainty has been estimated as a constant value for any subject, a result which is consistent with the previous models listed in Table 2.

4 Concluding remarks

The results so far discussed should convince of the adequacy and flexibility of CUB models as an alternative paradigm for the analysis of ordinal data. More specifically, a remarkable added value of the approach is the possibility to represent these models in a parameter space and to see how they are modified with respect to covariates.

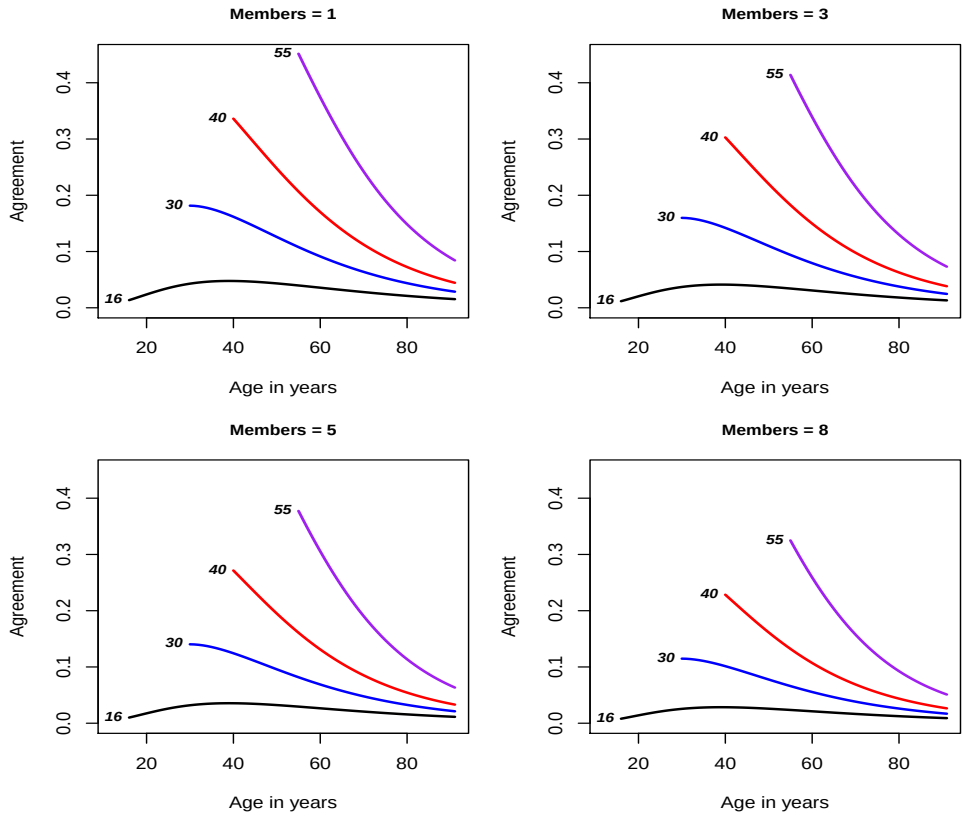

Figure 5: Joint effect of covariates on the agreement as estimated by CUB models

In this study, the application of CUB models to the EWCS data indicates that several aspects jointly affect the perception of conflict with ethical/personal values. Specifically, we observe that age of workers, their family size and age at the end of their education significantly influence results.

Performing a stepwise strategy, the relevance of covariates shows that the age has a parabolic effect on the perception of moral conflict since and it is clearly U-shaped. The number of family members has a negative effect. Finally the age at ending studies positively affects the perception of value conflict. Several other covariates could be used for explaining an agreement parameter whereas uncertainty seems determined as a constant in the survey.

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