

### ***The Partial Independence Item Response (PIIR) Model***

The PIIR model treats each provision in a CBA as a binary “response” to a survey that includes all contract provisions covered in collective bargaining agreements. Many “responses” in a CBA are conditional to responses earlier in the CBA. Therefore, the PIIR model uses as the dependent variable the *conditional* probability that a provision appears in a CBA *given* that it is in the “risk set” for that CBA (i.e. the item in question could have appeared in the CBA given response to previous questions). Specifically, if  $Y_{ik}$  represents the outcome of provision  $k$  in contract  $i$ , and  $h_{ik}$  represents whether this provision is in the “risk set” for contract  $i$ , we can let  $\varphi_{ik} = \Pr(Y_{ik} = 1 | h_{ik} = 1)$ . The model is then:

$$\log\left(\frac{\varphi_{ik}}{1 - \varphi_{ik}}\right) = \theta_i + \sum_{j=1}^K \gamma_j D_{ij} \quad (1)$$

In model 1, the conditional probability of provision  $k$  appearing in contract  $i$  is a function of the latent restrictiveness of CBA  $i$  ( $\theta_i$ ) and the conditional “severity” of provision ( $\gamma_j$ ).<sup>1</sup>  $D_{ij}$  is simply a dummy variable indicating which provision is considered. Thus, model 1 allows simultaneous calculation of the restrictiveness of each contract as a whole as well as the severity of each individual provision. For more detail on data coding and preparation see Goldhaber et al. 2012.

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<sup>1</sup> This approach is conceptually similar to a Rasch model (Rasch 1960) that calculates the probability of a student answering a question correctly on a test as a function of his or her latent ability and the latent difficulty of the question.