

The Rasch Model for Victimization Analysis: A Proposal of an Insecurity Perception Index

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Abstract: This work focuses on the use of the Rasch Model for a Victimization Analysis. We propose a new Citizen Perception Insecurity Index for the Italian environment, also referring to Regions or Geographical areas. We define this Index by the means of Person Location Parameter Estimates of Rasch Model. This procedure is particularly suitable for the determination of a synthetic value of the “Insecurity Perception” latent variable with reference to large data-sets.

Keywords: Rasch Model, Statistical methods for security, Fear of Crime Measures

1. Introduction

In this paper we consider the Rasch Model (RM), generally used in psychometrics, for investigating the insecurity perception of Italian citizens. The aim of the work is to measure the individual insecurity perception of a population by the means of a quantitative synthetic index. Henceforward the *insecurity perception* concept will be used to describe the risk perception to suffer an offence and/or the fear to be victim of a crime. In psychology and sociology this concept is generally called “*fear of crime*” (Hale, 1996, Jackson, 2005). We notice a shortage of quantitative indicators measuring the concept of *insecurity perception*. In the Italian literature several studies focused on a single aspect of the insecurity perception (e.g. home safety or feeling safe in neighbourhood) measured by the means of an unique question item in a survey; moreover these studies consider often data only from local surveys. Other studies investigate some aspects of the insecurity perception carrying out an indicator based on the answers to questions referring to different aspects of the interesting latent trait (Tseloni, 2007, Santinello et al., 2005). Furthermore, the aim of the above mentioned studies is to use these results to foresee the level of crime fear on the basis of proper explicative variables: environmental, behavioural, socio-economic or rate of crime (see, for example, Triventi, 2008, Tseloni, 2007, Hale, 1996). Osgood et al. (2002) measure the fear of crime and the concept of deviance using the Item Response Theory (IRT) models. In our work we use a particular IRT model, the RM, aiming at developing a synthetic *insecurity perception* indicator. The advantage of this method with respect to other ones is referred to the tested assumption of unidimensionality of the construct, and to the possibility of separating personal and objective characteristics. In our analysis we use the “Italian survey on citizens’ safety” data, within Istat Multi-scope Survey (2002). This study sample consisted of a representative Italian population sample of 60000 citizens, aged 14+. We used some of the survey items to build up the *Insecurity Perception Index*. In particular, we considered those grouped in the section III of the

survey, related to environmental safety perceptions, security measures and behaviours assumed in order to protect oneself against crime or to face the fear of being victim of a crime. The relationship between the response categories of the items and the construct is direct. Our insecurity perception measures are calculated either for nation-wide or for disaggregated geographical areas (North-West, North-East, Centre, South and Isles), comparing each other and evaluating the differences.

2. The Rasch Model

RM can be used as an alternative method to classical psychometric ones to assess how well a set of observations works when the observations are combined to measure an unobserved latent construct (*Insecurity Perception*). RM belongs to the family of IRT measurement models which converts raw scores into linear reproducible measurements. Under the hypotheses that *personal* and *objective* characteristics are separable, RM allows to construct a single metric scale in a sorting referred to two parameters groups: *Item* and *Person parameters*. The main limitation of classical methods is the non use of the hypothesis of separating respondents and items characteristics. RM is designed to estimate the subject's intensity on the latent trait, net of item characteristics, and items' net of subjects. The individual ability is evaluated by his placement along a latent continuum related to the difficulty of the scale items. With reference to a particular measurement scale, for a specific latent aspect (ability or opinion), let x_{ij} be the response of the generic unit $i=1, \dots, N$ to the item $j=1, \dots, J$ (typically given on a conventional Likert scale, choosing, among the integer values $k_j=1, \dots, m_j$). The probability of choosing x_{ij} , may be represented as a proper "link function" $\varphi(\theta_i, \beta_j)$, in the parameters θ_i, β_j accounting, respectively, for personal and item levels. RMs (see, for example, Fischer, Molenaar, 1995) consider the last relation to be a logistic type. In the family of RM, we consider the polytomous model, through resolution of relevant terms of a general form of Rasch's model into threshold and discrimination parameters; in particular we consider the Partial Credit Model (PCM), in the version known as *Extended Logistic Model* (ELM), proposed by Andrich (1988). The PCM allows different thresholds for different items. The PCM, in general, specifies that each item has its own rating scale structure. It derives from multiple-choice tests where rejected responses, indicating some information, give partial credit with respect to the real response. In the contest of victimization analysis, "ability" may be conceived as the individual crime fear (or individual *Insecurity Perception Index*): subjects with higher score in the ability subscale (Personal Location Scores) will have a higher level of insecurity and fear. Difficulty may be conceived as the item location on the latent continuum, and it reflects the fear for a particular aspect measured in the survey. In this way it is possible to order the survey's items on the basis of their importance when creating a synthetic Index. In our model, the ELM gives the probability that the subject i responds to item j through the answer x_{ij} :

$$P(X = x_{ij}) = \exp[\kappa_{k_j} + x_{ij}(\theta_i - \beta_j)] / \sum_{k_j=1}^{m_j} \exp[\kappa_{k_j} + k_j(\theta_i - \beta_j)] \quad (1)$$

with X is a random variable which describes the response x_{ij} of the subject i to the item j , κ_{jx} are the coefficients of each category k_j for each item j (note that the first and the last

parameters are equal to zero and that $\kappa_{k_j} = -\sum_{h=1}^{k_j} \tau_{jh}$, the category are defined in terms of thresholds, τ_{jh} is the h -th ordered threshold of item j). RM permits the separation of the person and item parameters; the item parameters can be estimated conditionally to person parameters estimation. This result is achieved through the use of conditional maximum likelihood estimation, in which the response space is partitioned according to person total score. The raw score for an item or person is the sufficient statistic for the item or person parameter. The procedure can be generalized naturally to handling missing data.

3. Results

The software RUMM 2010 has been used to analyse data and to produce the scale of items difficulties (worry for a particular item/aspect) and the scale of respondent measures (*Insecurity Perception Index*). Table 1 reports the estimated *fears ratings*; RM ranks most meaningful items by *item locations*, ranging from -0.882 to $+1.141$: high values identify less relevant aspects for the measure of fear latent trait; on the contrary, small values identify more alarming aspects.

Table 1: Fears rating: Item Location Parameters (β_j)

<i>Item</i>	<i>Description</i>	β_j	<i>Item</i>	<i>Description</i>	β_j
1	Safety walking alone in the dark	-0,058	7	Fear of having one's car stolen	-0,384
2	Avoiding places/people for safety reasons	-0,055	8	Fear of having one's home robbed	-0,882
3	Carrying self-defence items	1,141	9	Fear of pick/pockets	-0,270
4	Locking the doors	-0,038	10	Fear of robbery/aggression	-0,282
5	Fear to go out at night	0,536	11	Fear of sexual harassment	-0,112
6	Safety when home alone after dark	0,839	12	Influence of criminality on habits	-0,435

We obtained the same rating for national or Macro-areas analyses. The obtained scale of item is homogenous. The χ^2 test for each single item compares the observed answers distribution with the estimated one. The test statistic increases with the sample size n . For large value of n (in our study $n=60000$) we reject almost always the null hypothesis of the two distribution equality also for alternative hypothesis close to H_0 (Landenna et al. 1998). Comparing the graphics of the two distributions for the item with the highest value of the test statistic (the lowest p -value) we note the two distributions are very closed each other; therefore we could accept that every items don't misfit the model.

The appropriateness of the items to measure the construct is evaluated by *Person Separation Index* (value: 0.848): this indicates a good power of fit. The value of the Item Trait Interaction Test is 15548 (df 108, p -value<0.01). Assumed that the unidimensionality hypothesis is satisfied, it is possible to measure the "crime fear" in three particular aspects or components: a cognitive component (the concern/perception of risk to suffer an offence and/or to be victim of a crime – items 7, 8, 9, 10, 11), an affective component (items 1, 5, 6), a behavioural component or coping strategies (items 2, 3, 4, 12). The most significant items are related to the cognitive component. Moreover, by the RM we developed an index to evaluate the Citizen Insecurity Perception in Italian environment, referring to Macro-areas, following the geographical

areas ISTAT classification. The Index is the arithmetic mean of Individual Person Location Scores, (ranging from -4.81 to 4.31). Higher values of the *Insecurity Perception Index* indicate higher levels of insecurity and fear perceived by Macro-Areas citizens. The National and Macro-Area Index are presented in Table 2. South Area is characterized by the highest value of the Index (highest insecurity level).

Table 2: Perception Insecurity Index

<i>Areas</i>	<i>Italy</i>	<i>North-West</i>	<i>North-East</i>	<i>Centre</i>	<i>South</i>	<i>Isles</i>
Index	-0.593	-0.568	-0.719	-0.632	-0.450	-0.672

We note that all the measures of fear related to the macro areas are negative. With respect to the metric scale, it means that people have a lower insecurity perception with respect to all the items. Estimated personal scores (*Individual Insecurity Perception Index*) may be used to represent the dependent variable of predictive victimization models or crime and security scenarios. RM gives an alternative and more efficient procedure to determinate the dependent variable in complex criminological models. Considering a multiple-item approach, our method can be improved to define a latent variable, summarizing different aspects of the same latent trait of interest (fear of crime).

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