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Assessing farmers' risk attitudes based on economic, social, personal, and environmental sources of risk: evidence from Sweden

By

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Abstract

This paper examines farmers' risk attitudes, obtained by responses to sources of risk, using an attitudinal scale approach. Economic, social, personal, and environmental sources of risk are considered in the measurement of risk attitudes. In addition, use of various types of expertise and information sources are included as risk management tools. Inferences are drawn from results of a survey mailed to a representative random sample of 500 farmers drawn from the population of medium to large farms (by acreage) in southern Sweden. Regarding the adequacy of the results it was found that a mail survey produces results similar to earlier results obtained by personal interview. Farmers' responses to the attitudinal scales showed levels of communal variation between 80 and 83%, which is higher than the result reported by Bard and Barry (2000) (68.6%). This indicates that a broader field of risk sources improves the measurement of risk attitudes. The results further indicate a slight degree of risk aversion and that crop and livestock farmers use different sets of risk management tools, depending on their risk attitudes. The results of this work are of relevance because if attitudes induce risk response, then the communication approaches for extension services or policy makers will be very different than if it is 'risk', as that word is typically used.

Keywords: Risk attitudes, Attitudinal scale, Economic risk, Social risk, Personal risk, Environmental risk

JEL Classification: Q12, D 81.

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island, July 24-27, 2005

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Introduction

There is a substantial body of evidence that supports risk response in agriculture and its relevance to economic decisions. Our identification and understanding of why risk response occurs and how it motivates observed behavior is very limited, however (Just and Pope, 2003). But such knowledge is imperative for example, in order to, improve agricultural policy analyses. Existing explanations of risk response include preferences, technology, and financial asymmetries (see Just and Pope, 2003). Farmers' risk attitudes have been studied using various estimation techniques (direct elicitation of utility functions, experimental procedures with hypothetical questionnaires, and inference from observation of economic actions) (e.g. Anderson *et al.*, 1977; Moscardi and de Janvry, 1977; Dillon and Scandizzo, 1978; Binswanger, 1980; Antle, 1987; Hardaker *et al.*, 1997; Lien, 2002) based on various theories (see Robison *et al.*, 1984; Moschini and Hennessy, 1999 for reviews of these works). In general, much of the empirical work in this vein has been criticized for disparity in results and much of the theoretical work has also been criticized as individual behavior does not reflect the results expected from theory.

Attitudes have played a central role in the psychological literature on understanding human thought and behavior. Attitudes are usually defined as 'general and enduring favorable or unfavorable feelings about, evaluative categorizations of, and action predispositions toward stimuli' (Cacioppo and Berntson, 1994 p.401). Clearly, attitudes are not *per se* synonymous with behavior, though a meta analysis by Kraus (1995) confirms that attitudes significantly and substantially predict future behavior. Recent work confirms that attitudes are more closely associated with behavior when they are related to risks than when they are related to benefits (Sjöberg, 1999). Substantial evidence actually suggests that attitude is the driving force for risk perceptions, rather than the converse (Sjöberg, 1980, 2003). So, if one is to approach and begin to understand risk response in terms of an individual's behavioral response to risk, it seems relevant

to study attitudes that are linked to specific sources of risk, as those attitudes will influence the way that we as individuals manage these risks (Robison *et al.*, 1984; Hardaker *et al.*, 1997).

According to work by Thurstone (1931), people's feelings about an object or an issue can range anywhere between two extremes: maximally positive and maximally negative. Assuming that individuals control the reciprocity of the positive and negative evaluation process, this allows attitudes to be measured along a positive - negative continuum. A person's risk attitude will work as a latent variable, as it is not directly observable, whereas the items (or various behaviors) that tap it will be (DeVillis, 1991). A scale developed to measure risk attitude will then regard attitude as a cause of behavior. If several related behavioral responses are used to measure risk attitude, one can invoke risk attitude as a basis for correlations among the responses, and use that information to infer the degree of relationship between the latent risk attitude and the items related to it (i.e. the magnitude of the risk attitude). Several studies have developed attitudinal scales to measure attitudes (e.g. Hube, 1998 for investment risk; McIver and Carmines, 1981 for self-esteem). Bard and Barry (2000) developed an attitudinal scale to measure risk attitudes proxied by various responses to risks (financial, marketing, and production) in production agriculture for a set of 86 farmers in Illinois. Their findings obtained through personal interviews, and later results obtained by the experimental "closing-in" method (Bard and Barry, 2001), indicated mild degrees of risk aversion; also that a respondent's self-perception of his risk attitude is not a reliable measure of his underlying attitude.

While most studies directed at measuring farmers' risk attitudes have focused primarily on aspects like weather, output prices, input costs and credit conditions, there is evidence that other sources of risk are important in agricultural decision making. Government programs, environmental regulations, tenancy position, family plans, concerns about the health and safety of themselves and family were of greater concern to farm managers than price and production

variability (Patrick *et al.*, 1985; Patrick and Ullrich, 1996). Recent developments, both in the USA and in the EU have accentuated the role of the environment in agriculture (Babcock *et al.*, 2003), as well as the social dimensions of agriculture. Although environmental risk has been identified in the literature (Baquet *et al.*, 1997), the focus has been on the risk of lawsuits and changes in government regulations (Musser and Patrick, 2003). Recognizing farmers as “stewards of the countryside”, however, widens the purview of sources of environmental risk. Furthermore, social capital is usually defined as “the norms and networks that define groups and influence actions of people within groups” (Castle, p. 1208) but little attention has been paid to social capital as a source of farmers’ risk-taking. In addition, an extensive literature suggests that farmers’ actions result from complex processes influenced by socio-economic and psychological variables (see Willock *et al.*, 1999, for an overview of references). Hence, personal risks also need to be recognized as a source of risk in agriculture. This is accentuated by work showing evidence of lack of distinction between business and personal risk among small businesses (Ang *et al.*, 1995).

The aim of this paper is to elucidate farmers’ risk attitudes, proxied by responses to sources of risk, using an attitudinal scale approach. As a novelty, the work by Bard and Barry (2000) is extended to include social, personal, and environmental sources of risk in the measurement of risk attitudes. In addition, various types of expertise and information sources are included as risk management tools in this study, based on results from the psychometric literature where trust in experts and institutions generally is found to explain human behavior (Fischhoff *et al.*, 1978).

Statements about managing risks were distributed to a representative random sample of 500 farmers drawn from the population of medium to large farm operations (by acreage) in southern Sweden, with the objective of identifying a set of statements that provide the optimal

amount of information about risk attitudes and establishing a score reflecting a quantitative measure of attitudes. Finally, a cluster analysis discerns large disparities in the relationship between attitudes, depending on farm type between risk sources.

Defining sources of risk

Risk affects the choice set of farm operators and various classifications of sources of risk and management responses to these risks relevant to agricultural businesses are available (e.g. Barry *et al.*, 1985; Baquet *et al.*, 1997; Hardaker *et al.*, 1997). Here, risks are generalized into three categories: economic, social and personal, and environmental. For each category, management responses are identified and listed. The notation introduced is used in the list of risk attitude statements presented in the Appendix.

Economic risks are related to exposure to an uncertain economic outcome of the farm business. Management responses are divided into the following areas: market/price (EM), production (EP), financial (EF), and contract (EC).

Social and personal risks are related to the social and personal context of the farmer and concern the retroactions to the farm business operation from that context. These sources of risk - and management responses to these risks - are divided into four areas: experience (SE), involvement (SI), attitude (SA), and prerequisites/qualifications (SQ). Experience is about the personal benefits derived from being a farmer. Understanding and interest from family, self-esteem, succession issues, and solitude in decision-making are the main elements in this risk category. Involvement (or personal relevance) is related to the extent to which the farmer perceives him- or herself as being able to affect the decisions within and the direction and prospects of the farm business. An increasingly institutionalized business environment, together with various types and levels of policy uncertainty, will contribute to the importance of this type

of risk. Human capital and psychological characteristics of the farmer define the individual responses to this type of risk. Attitude concerns the extent to which the farmer perceives the importance of having a social network. An open attitude might, for example, be of relevance in information gathering and in the adoption of new technology. Finally, prerequisites/qualifications are related to constituents of the social context. Proximity to neighbors and distance to urban areas or villages are factors relevant to the possibility of an active social intercourse including access to off-farm labor markets, schools and other public and private services.

Environmental risks are related to the dependence of agricultural production on the natural environment, taken broadly to include various aspects, and conversely, to the production activities and their impact on the natural environment. The potential repercussions on the farm business operation of these dependences and impacts constitute types of environmental risk that are considered in this study. Five different areas of environmental risk and management response are considered: nutrient leaching to ground water (EnvW), nutrient leakage to air (EnvA), dispersal of chemical residues (EnvC), biological diversity (EnvB), and animal welfare (EnvAW).

Scale design

A risk attitudinal scale was developed to measure farmers' risk attitudes based on the way that they manage risk according to the methodology used by Bard and Barry (2000). It was paramount in the design to relate attitudes to risks that are private rather than general (related to others), as recent research has found this distinction to relate both to incentives for controlling risks, and to how people judge the importance of risks (Sjöberg, 2003).

A questionnaire was devised together with industry representatives and academic researchers specializing in rural development and environmental extension services aiming to

formulate a policy-relevant and meaningful questionnaire for respondents. The definitive questionnaire was preceded by: (a.1) a pre-test survey of risk management statements related to economic risks, (a.2) an analysis of personal interviews with 30 farm operators to identify sources of social and personal risks, (a.3) a review of recommendations for environmental best practices, (b) pre-tests of the set of risk management statements including economic, social and environmental risks, using one focus group (comprising 5 farmers), and (c) final revision of the suggested set of statements by experts.

The pre-test survey, mailed to a random sample of 617 farmers in southern Sweden in 2002, included a set of 32 statements related to economic risks. An analysis similar to the one adopted in this paper found a degree of communal variation of 63.2% and that a refined set of 24 statements optimized the scale, thus improving the degree of communal variation to 69%. Respondents also clearly indicated environmental concerns to be of great importance in their production. This motivated the extension in this study to address environmental risk management strategies in greater detail. Taken together, these pre-test measures were assumed to ensure content validity (i.e. item sampling adequacy).

Altogether, 80 statements (or scale items), each of which was thought to reflect the scale's purpose, were included in the questionnaire (see Appendix). Needless to say, statements can be related to more than one source of risk. Therefore, the classification of statements in the Appendix relates statements to the most obvious type of risk source. No attempt was made to equalize the number of statements or management responses to risk from each major source of risk in the design of the questionnaire. Instead, the balance of statements between categories of risk management tools follows from the pre-tests and the intention to make sufficient allowance to encompass the construct being measured (DeVillis, 1991:56). Allowance is generally positively related to the reliability of the scale, as the content that is common to a set of similar

statements will summate across these statements, while their irrelevant idiosyncrasies will cancel out (DeVillis, 1991:56).

In order to avoid agreement bias, positively and negatively worded statements were included interchangeably. Bold-numbered statements (presented in the Appendix) were given with a reverse wording in the questionnaire. A Likert scale with five response options was selected as the measurement format. The initial testing of the questionnaire included six response options and a neutral midpoint as recommended by DeVillis (1991, p.68) but focus group members drew attention to problems in distinguishing between the response options ‘moderately disagree (agree)’ and ‘mildly disagree (agree)’. The selected approach with five response options coincides with the response options used by Bard and Barry (2000). Moreover, each heading in the questionnaire included a ranking of the response options to allow the respondents to distinguish meaningfully to the number of response options. The following rank was used: (1) strongly disagree, (2) do not agree, (3) neither agree nor disagree, (4) agree, and (5) strongly agree. The lower the individual statement score is, the more likely the farmer is to take measures to deal with the risk in question. A lower total score for an individual is then hypothesized to correspond to a higher degree of risk aversion. An average score of 3 corresponds to risk neutrality. Statements were formulated to be fairly strong and specific in order: (i) to allow for a useful differentiation among respondents (DeVillis, 1991), (ii) as people have been found more likely to behave in a fashion consistent with their strong attitudes than with their weak ones (e.g. Kraus, 1995), and (iii) since a specific definition of an attitude is more likely to predict a particular action. Fig. 1 illustrates a risk management attitudinal statement and choice options in the questionnaire.

Figure 1. *Example of risk management attitudinal statement and choice options in the questionnaire*

Statement	Strongly disagree				Strongly agree		not relevant
	1	2	3	4	5		
31. I never hire a production extension specialist before taking major decisions in my firm.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The option ‘not relevant’ was used as an opt-out alternative, meaning that respondents were instructed to use this alternative only if they found that a given statement was not relevant to themselves.

Sample and responses

The resulting questionnaire consisted of three parts. The first part included questions about the respondents’ demographics and farm characteristics. The set of risk management statements to be used for developing an attitudinal scale to assess farmers’ attitudes towards risk constituted the second part. The third part of the questionnaire contained the experiment used to validate the risk attitude scale developed from the second part.

The questionnaire was mailed to 500 sole proprietors in six counties in southern Sweden (Stockholm, Södermanland, Uppsala, Västmanland, Örebro, and Östergötland) during the period October 2003 to December 2003. It was imperative in the selection of counties to study a geographic area where no European Union or national grants for the environment (i.e. subsidies to reduce nutrient leakage) are given, in order to obtain responses due solely to economic incentives. The random sample was drawn by Statistics Sweden to be representative of the population of farmers operating more than 50 hectares ($n = 5,180$). The type of farming of those farm operations selected for inclusion in the sample was not known in advance, as Statistics

Sweden do not keep such information. The acreage restriction is motivated to ensure that respondents are to a considerable extent dependent upon farm income to defray their living expenses. In addition, it is assumed that such dependence is positively related to the importance of risk management strategies in the decision-making processes for these farmers. Table 1 presents concise demographic and business statistics of the sample: the sample has been dichotomized according to main type of farming, as the following analysis will focus on these farm types.

Table 1. Concise statistics from the mail survey of farmers in southern Sweden with more than 50 hectares of farmland

Average circumstances as of year 2003 per farm type (standard deviations in parentheses).

	Crop production	Livestock production
No. of respondents	120	108
Farmer's age (years)	52.3 (10.6)	50.8 (10.1)
Farming experience (years)	25.2 (13.3)	26.7 (11.7)
Civil status (1 = married or cohabiting; 0 otherwise)	0.83 (0.37)	0.89 (0.3)
No. of persons in household	2.75 (1.26)	3.21 (1.47)
Acreage owned (ha)	63.8 (55.3)	65.4 (56.8)
Acreage farmed (ha)	116.4 (82.2)	129.9 (117)
Share of owned land	0.62 (0.38)	0.58 (0.34)
Net farm income year 2002 (SEK)	173,313 (177,328)	226,496 (219,547)
Book value of Total Farm Assets, end of 2002 (SEK)	2,674,677 (2,131,756)	3,735,716 (3,830,923)

Note: In November 2003, 1 SEK \approx \$7.625

Altogether 271 (54%) individuals returned the questionnaire, of which 228 (46%) were available for analysis. The two causes for unavailability were (i) the farmer had ceased production (25 individuals), (ii) non-responses to various parts in 18 questionnaires.

In the group of 108 farms with livestock production, the self-reported types of

specialization were: 22, dairy; 15, beef; 3, hogs; 18, mixed arable and dairy; 28, mixed arable and beef; 3, mixed arable and poultry; 6, mixed arable/dairy/beef; 3, mixed arable and hogs; and finally 10 farms reported a mix of other types of livestock production.

Respondents with arable farming as their main business activity consistently selected the opt-out alternative for 24 statements related to risk management methods in livestock production. The decision was therefore taken to pursue a separate analysis for two groups of farm types: arable production and livestock production. A relatively homogeneous sample reduces sources of other variation that could have been present in a more heterogeneous group. The preliminary set of 58 statements answered by arable farmers included 25 statements related to economic risk¹, 14 to social and personal risk, and 19 to environmental risk. The corresponding preliminary set of statements answered by livestock farmers included 28 statements related to economic risk, 14 to social and personal risk, and 38 to environmental risk.

For arable farmers, the preliminary set of statements provided an average statement score of 2.64 (standard deviation 0.318), while the average score for the preliminary set of statements directed to livestock farmers was 2.57 (standard deviation 0.283). This implies a modest agreement with the importance of using the risk management tools.

Reliability testing

The reliability of attitudinal scales depends on the extent to which individual statements reflect the risk attitude of the respondents. Cronbach's coefficient alpha was used to measure the degree of communal variation of the attitudinal scale (DeVillis, 1991). It is measured as:

¹ Statements 21, 62, and 75 are related to economic risks in livestock production and these statements were found 'not relevant' by arable farmers.

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum \sigma_i^2}{\sigma_y^2} \right)$$

where k is the number of statements in the scale, σ_i^2 is the variance of the i th statement, and σ_y^2 is the total variance of the k -item scale (DeVillis, 1991).

For arable farmers the preliminary set of 58 statements provided an overall alpha value of 0.7591, while the overall alpha value for the preliminary set of 80 statements directed to livestock farmers was 0.7816.

The standard way of improving the reliability of a scale being developed is to delete statements with a weak relationship in responses to remaining statements' responses (DeVillis, 1991; Bard and Barry, 2000). Usually, the corrected item-scale correlation (CISC) is adopted as a measure of such relationships. It is represented as:

$$r_{i(y-i)} = \frac{r_{yi} \sigma_y - \sigma_i}{\sqrt{\sigma_i^2 + \sigma_y^2 - 2\sigma_i \sigma_y r_{yi}}}$$

where r_{yi} is the correlation of statement i with the total score y , σ_y is the standard deviation of the total score y , σ_i is the standard deviation of statement i , and $r_{i(y-i)}$ is the correlation of statement i with the sum of scores of all the statements, y , exclusive of statement i (Bard and Barry, 2000: 12). Table A1 (Appendix) shows the CISC values for both scales. Both scales were then optimized by deleting statements with a negative or low-item scale correlation. This iterative procedure proceeds until the total alpha value cannot be increased any further. Continuing to delete statements would reduce the total alpha value. This was done to obtain a refined set of statements for each farm type that reliably measures farmer's risk attitudes.

For arable farmers the following 27 statements were deleted: 7, 10, 11, 12, 14, 16, 22, 24, 25, 28, 30, 33, 36, 38, 39, 41, 42, 47, 48, 49, 54, 55, 56, 61, 66, 68, and 69. Deleted statements represented all risk management areas except market/price risks, contract risks, and risk related to biological diversity. The overall coefficient alpha for the remaining 31 statements was 0.8012, indicating that a communal variation of 80% is caused by risk attitudes. The refined set of statements for farms with crop production includes 12 related to economic risk, 8 related to social and personal risk, and 11 related to environmental risk. The average statement score for the refined set of statements for crop producers was 2.58 (standard deviation 0.46).

For livestock producers the following 24 statements were deleted: 4, 8, 10, 12, 13, 20, 22, 24, 25, 34, 36, 38, 44, 48, 51, 54, 57, 60, 61, 64, 65, 71, 74, and 77. These deleted statements again represent all risk management areas except market/price risks, contract risks, and risk related to biological diversity. The refined set of statements for farms with livestock production includes 21 related to economic risk, 10 related to social and personal risk, and 25 related to environmental risk. The final overall coefficient alpha for the livestock scale was 0.8338. The average statement score was 2.55 (standard deviation 0.4).

Construct validity testing

The extent to which measures of risk attitudes are related to demographic and socio-economic characteristics is an important aspect in validating the refined attitudinal scales. Earlier studies of risk attitudes have found no such systematic relations (Bond & Wonder, 1980; King & Oamek, 1983; Tauer, 1986, Bard & Barry, 2000). Previous findings have, however, been based on ANOVA testing, which is not applicable to the responses in this study as the design of the sample was not made to select farm operators from any pre-specified group of characteristics, other than by geographic region (selected counties) and extent of operated acreage. Instead, canonical

correlation analysis (Hotelling, 1935; 1936) is applied to analyze the relationship between socio-economic characteristics of respondents and their responses to the refined set of attitudinal statements. Age of farm operator, farming experience, number of individuals in the household, farmed acreage and share of owned land were used as socio-economic variables. Table 2 includes the results obtained from the CANCELL procedure in SAS.

Table 2. Canonical correlations and test statistics between socio-economic characteristics and their responses to the refined set of attitudinal statements

	Arable farms	Livestock farms
1 st Canonical correlation	0.787	0.883
2 nd Canonical correlation	0.653	0.845
<i>p</i> -value for 1 st Can. Corr.	0.1005	0.2305
<i>p</i> -value for 2 nd Can. Corr.	0.7491	0.6422
Wilks' Lambda	0.1005	0.2305
Pillai's Trace	0.1467	0.2255
Hotelling-Lawley Trace	0.0696	0.2596
Roy's Greatest Root	<.0001	0.0034

Note: Canonical correlations of higher orders are not presented, as they are highly non-significant.

The first canonical correlation is the closest possible between any linear combination of socio-economic variables and the risk attitude responses. *p*-values are associated with the hypothesis that a given canonical correlation (and all that follows) is zero. For the group of arable farmers there is doubt to fail the hypothesis for the 1st canonical correlation. For this group of respondents, the standardized canonical coefficients for the socio-economic variables are: 0.87 for age of operator; - 0.85 for farming experience; 0.18 for number of individuals in household; 0.58 for acreage farmed; and 0.85 for share of owned land. This indicates how a person belonging to this group would score on the set of refined risk statements. However, we do not reject the hypothesis that all canonical correlations are zero in the population of livestock farmers, as the *p*-values and the multivariate test statistics are large.

Principal component analysis and factor analysis

A principal component analysis was conducted to establish whether or not the variance of the responses to the set of refined statements can to any great extent be explained by a few linear combinations of such statements. If so, then these components can replace the initial set of statements, and the validity of the larger set of statements to measure attitudes to risk as a latent variable is jeopardized. For the set of arable farmers the analysis indicated 25 principal components of the covariance matrix² with eigenvalues >1, explaining 84.9% of the total variance. An evaluation of the principal components obtained, using a 'scree'-plot of the magnitude of eigenvalues versus their corresponding rank, did not reveal that any of the components effectively summarize the total sample variance. The first principal component, which is the linear combination with maximum variance, explains only 11.5% of the total variance. For the set of livestock farms, the analysis also indicated 25 principal components of the covariance matrix with eigenvalues >1, explaining 83.9% of the total variance. The first principal component here explains 9.9% of the total variance. The large number of principal components needed, for both farm types, to explain most of the sample variation indicates that it is not possible to present data in a few dimensions.

A factor analysis was conducted to further test if it is appropriate to describe the covariance relationships among the responses to the set of statements in terms of a few underlying but unobservable random factors. Estimations were made using both the principal components method as well as with the maximum likelihood method. In general, one finds that it is not possible to identify any unambiguous patterns of how variables are related to factor

² A principal component analysis using the covariance matrix is preferred, as the variables (responses to statements) are measured on the same scale (i.e. do not need to be standardised) (Johnson & Wichern, 1998).

loadings. For arable farmers, 28 of the statements selected for the refined scale of 31 statements appear among the 50 statements contributing the highest factor loadings in the first six factors, while for farmers with livestock production, 39 of the statements selected for the refined scale of 56 statements appear among the 53 contributing the highest factor loadings in the first six factors. These results are similar to the findings of Bard & Barry (2000) and support the validity of the refined scales.

Cluster analysis

Cluster analyses were conducted on the refined sets of risk management statements to classify statements into groups, as such potential groups concerning relationships between statements are initially not known. The primary objective was for each farm type, to discern the structure of responses to statements relating to economic-, social-, personal-, and environmental risk management strategies.

The complete linkage method was applied, as distance values change from step to step was smaller with this method. The design of this method ensures that all statements in a cluster are within some maximum distance (or minimum similarity) from each other (Johnson & Wichern, 1998). Figures 2 and 3 reveals the dendrograms for crop production and livestock production, respectively.

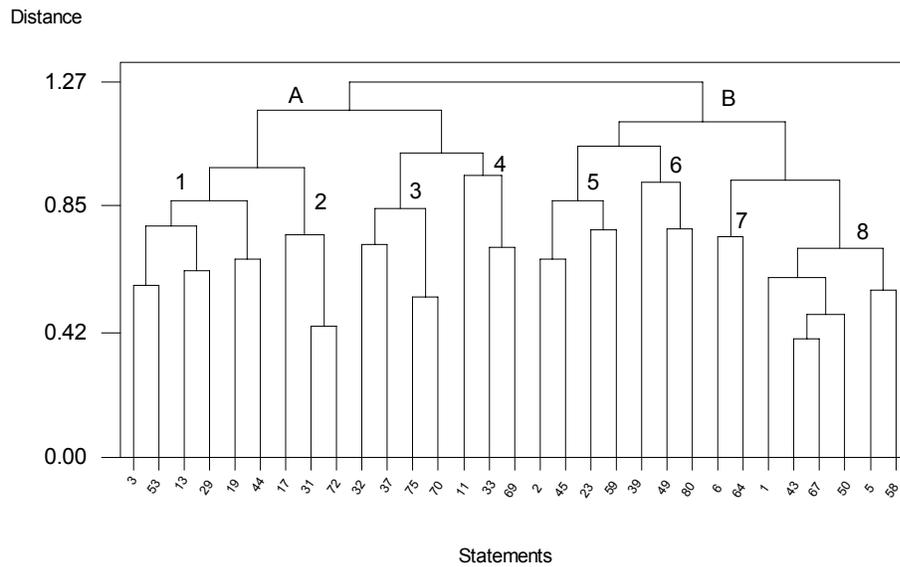


Figure 2. Complete linkage dendrogram for distances among responses to the 31 statements selected for the refined scale of risk management statements for farms with crop production. A and B denote main clusters and numbers indicate sub-clusters (i.e. grouped statements).

For the group of arable farmers, two main clusters (denoted A and B in Fig. 2), each with three sub-clusters, were identified.

The first main cluster (A) involves sub-clusters 1, 2, 3, and 4, including statements within all risk management areas, market/price risk, social involvement, nutrient leakage to air, and biological diversity. In total, there are 7 statements relating to economic risks, 3 directed towards social risks, and 6 statements related to environmental risks.

The statement scores in sub-cluster 1 imply an almost neutral attitude towards taking large environmental concern in production (3). Farmers do however adjust the amount of nitrogen to the need of the crops (53). Participation in study circles (13) and soil mapping (29) are interrelated and modestly supported. In the final pair, sustaining high quality production even entailing higher costs (19) is related to the proximity to larger towns or conurbations (44). These findings indicate that a moderate use of nitrogen (fertilizers) might be more closely related to an

economic use of resources than to strict environmental concerns. It is interesting to note that social attitude plays a role here. An increasing environmental awareness might require proper training but respondents exhibit a modest interest in such activities.

The relationship between statements 31 and 72 in sub-cluster 2 is natural, since both are related to use of extension specialists. Respondents reveal a reluctance to engage such specialists before taking major business decisions. The closeness to statement 17 (showing that production contracts are common) indicates an inverse relation between contracting and use of extension specialists.

Sub-clusters 1 and 2 are interrelated, which emphasizes the role of this cluster as dealing with the relation between personal attitude and production risks, both economic and environmental.

The grouping of (32) and (37) in sub-cluster 3 is reasonable, as both statements deal with actions minimizing the use of chemicals. The grouping of (75), about contacts with neighbors, and (70), use of chemicals according to a widely accepted program, is related to (32) and (37). This intriguing relationship might indicate that the use of chemicals is influenced by how individuals perceive themselves to be regarded.

Then in sub-cluster 4, statements (33) and (69) are both related to financial risk. Financial institutions also frequently use these statements to measure financial pressure in credit evaluations of small business operations. The relationship to statement 11 indicates this cluster to be characterizing absence of premeditation.

The second main cluster (B) comprises sub-clusters 5, 6, 7, and 8. Cluster B involves statements within all risk management areas except contract risks and nutrient leakage to water and air. There are 5 statements altogether, related to each of the three main risk management areas.

Sub-cluster 5 involves the pair (2) and (45) that relate available time for desired social activities vs. off-farm investments. The related statement 23 concerns individual attitudes to the importance of participating in social activities. The responses here suggest a disparity between attitudes and realization and that investment is focused on the farm business, thus risking gains from diversification. The relation to statement 59 (adequate insurance against accidents) is less obvious.

Interestingly in sub-cluster 6, perception about the possibility of influencing the future direction of the farm business (49) is related to reliance on information (80). This finding suggests that ability to independently affect the future of the farm business stands in contrast to trust in printed information. The related statement 39 concerns the extent of hobbies unrelated to agriculture and is associated with individual attitude. More extrovert individuals might be more self-confident concerning the potential to affect the future of their business.

Sub-clusters 5 and 6 concern statements that are directed to the farmer as an individual and are characterized by the union of social engagement and self-confidence.

In sub-cluster 7, statement 64, concerning solitude or self-exposure in decision-making (i.e. lack of contact with other farmers to discuss business issues), is related to statement 6 concerning administrative control and verification. This sub-cluster is related to sub-cluster 8 where statements 43 and 67 are naturally close. Statements 1, 50, 5 and 58 are also logically related, as the requirements for a zone free from spraying (50) to enhance biological diversity, and policies for use of a sprayer, are usually stipulated in such major quality programmes as are reflected in statement 1.

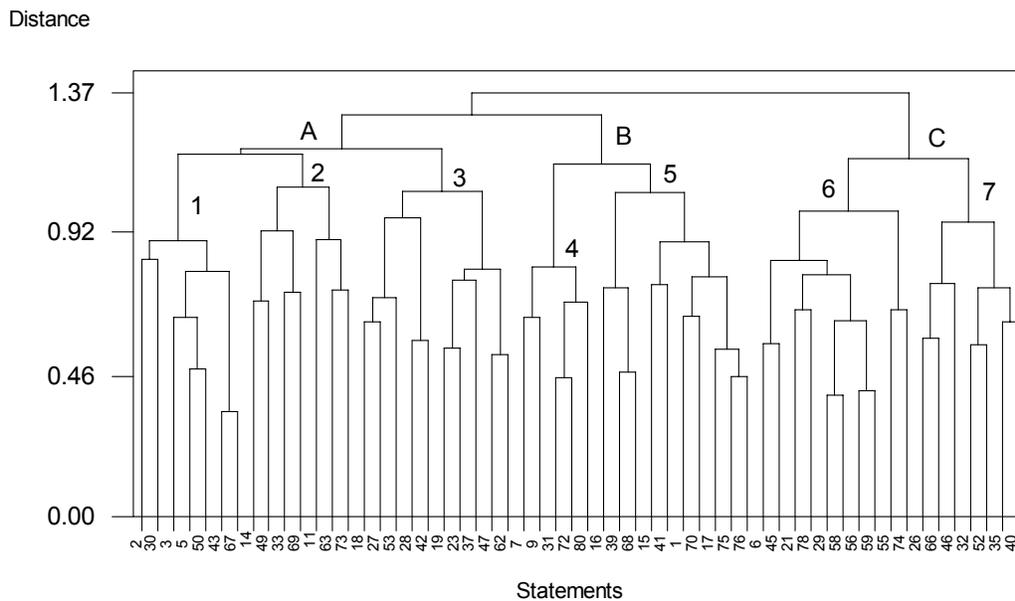


Figure 3. Complete linkage dendrogram for distances among responses to the 56 statements selected for the refined scale of risk management statements for farms with livestock production.

For the group of livestock farmers, three main clusters of responses in the refined scale of risk management statements (denoted A, B, and C in Fig. 3) were identified.

The first main cluster (A), comprising sub-clusters 1, 2, and 3, includes statements within all risk management areas except market/price risk and contract risks. There are altogether 6 statements relating to economic risks, 6 concerning social risks, and 12 related to environmental risks in this main cluster.

Sub-cluster 1 includes statements 43 and 67, again naturally close. Statements 3, 5, and 50 are also logically related; the requirements for a zone free from spraying (50) to enhance biological diversity, and handling of the sprayer (5) are related to environmental concerns in production (3). These statements are related to time for leisure activities (2) and inter-farm collaborative use of machinery (30).

Sub-cluster 2 is a group of environmental risk management tools characterized by carefulness and elaboration. The relationship between use of chemical weed control after harvest (14) and the possibility of influencing decisions concerning the future of the firm (49) is not obvious. These statements are, however, related to the financial risk statements 33 and 69, which again are interdependent. Finally, statements 11 (spring ploughing), 63 (mulling of manure directly after spreading) and 73 (use of catch crops) are naturally related.

Sub-cluster 3 includes two main groups of related statements. The first indicates that actions to enhance animal well-being and balanced use of fertilizers are related to how the farmer as an individual experiences his involvement (28) and interest in the (future) farming business (42). Active family involvement might stimulate the farmer to actively comply with modern production practices. The second group emphasizes quality production even if this entails higher production costs: statement (19) concerns attitudes toward the importance of participating in social activities (23). Statement 37 (adjust crop rotation to minimize the needs for chemicals) is logically related to (19) as such a measure impinges on short-term profits. Having back-up labor by employees or temporary help in case of illness (47) is reasonably related to a well-documented livestock production (62).

The second main cluster (B), involving sub-clusters 4 and 5, includes statements within all risk management areas except social involvement, social qualifications, risk of air-borne nutrient leakage, biological diversity and animal welfare. In this main cluster, there are altogether 10 statements relating to economic risks, 3 concerning social risks, and 2 related to environmental risks.

In sub-cluster 4, the relationship between statements 31 and 72 is again natural, as both are related to the involvement of extension specialists. Similar to responses among arable farmers, responding livestock producers reveal a reluctance to engage extension specialists before

taking major business decisions. Moreover, lack of trust in printed information for use in taking operating decisions (80) highlights this group characterizing independence and dissociation from expertise. Related to this is engagement through being associated with organizations by commissions in trusts (7), and farm investment for size expansion (9). Responses here indicate that many of the responding farmers do not have many commissions in trust.

Sub-cluster 5 includes two related groups of statements. In the first group, personal commitment, expressed through hobbies unrelated to agriculture (39), is found to be related to absence of short-notice back-up to deal with production practices in case of emergency (68). These statements are in turn related to postponing acquisitions of input factors for the production (16). In the second group, spreading of manure in the fall (15) is logically related to having an older and less well-maintained machine park (41). Moreover, access to quality programs for crop production (1), although respondents have indicated that a large part of their production is not acceded, is naturally related to compliance with standards for the use of chemicals within such programs (70). Furthermore, close contact with neighbors (75) is related to a combination of high productive efficiency and a high standard of animal husbandry (76). The latter pair of statements is related to having the bulk of production on contracts (17).

The third main cluster (C), involving sub-clusters 6 and 7, includes statements within all risk management areas except contract risks, risks related to social experience, involvement, and attitude, and risks related to biological diversity. In this main cluster, there are altogether 5 statements relating to economic risks, only 1 concerning social risks, and 11 concerning environmental risks.

In sub-cluster 6, thorough and well-documented checks on production (6) are related to not investing a large proportion of household income outside the business (45). Accession to livestock quality programs (21) is related to a balanced use of fungicides (78). The latter two

statements are in turn related to pairs 19 & 58 and 56 & 59. The first pair concern soil mapping (29) and regular testing of the function of the sprayer (58). The second pair reveal a reasonable similarity in responses concerning life insurance cover (56) and insurance against accidents (59). The extent of year-round residence (55), and capturing availability of social prerequisites, relate to timely ploughing in the fall (74). These two statements subsequently relate to the other statements within this sub-cluster.

In sub-cluster 7, statements (26), (66) and (46) are concerned with the use of the equipment in order to minimize nutrient leakage to the atmosphere and water. The grouping of a moderate use of chemicals for weed control (32) with animals having plenty of straw bedding (52) is not self-evident. A close relationship between animal sickness (35) and mortality (40) is found, however. It is reasonable to characterize this sub-cluster as dealing with managerial ability with respect to nutrient leakage and especially with animal welfare, as sickness and mortality are direct indicators of inadequate welfare.

Conclusions

This paper applies an attitudinal scale approach to ascertain farmers' attitudes to risk. Regarding the appropriateness of the findings it was found that mail survey results were similar to earlier responses obtained by personal interview. Farmers' responses to the attitudinal scales revealed levels of communal variation between 80 and 83%, which is higher than findings by Bard and Barry (2000) who reported 68.6%. This indicates that a broader field of risk sources improves the measurement of risk attitudes. Our results further indicate mild degrees of risk aversion and that crop and livestock farmers use different sets of risk management tools, depending on their risk attitudes. In general, social and personal risks are of relatively less importance for farmers with

livestock production than for farmers with arable production. The converse applies to environmental risks.

The results of this work are of relevance, because if attitudes induce risk response, then the communication approaches for extension services or policy makers will be very different than if it is 'risk', as that word is typically used. *Ex ante*, 'risk' is commonly related to a perceived variability in a specified objective constituted by incomplete information, while methods of subjective probability assessment often form the basis of decision analyses. On the other hand, attitudes are formed from beliefs in alternatives (consequences) and evaluations of beliefs in terms of advantage (Fishbein and Ajzen, 1975). Analytical cognitive aspects, dealing in a reason-oriented way with what the farmer knows or is aware of, affect his predictive judgment. Evaluation of beliefs, in turn, will be guided by affective variables. Routes to attitude change need to recognize that affection and analytical cognition represent conceptually different dimensions, in that they are related in very different ways to the active processing of information. Moreover, early studies found that attitudes are learned and are the result of past experience (Campbell, 1963). The latter may be one's own, or experience communicated from others. In view of this, the reluctance found in this study among farmers to engage extension experts and veterinarians, thus forgoing for example potential learning effects, appear to be risk seeking behavior. To provide an understanding and identification of why risk response occurs and how it motivates observed behavior, future work needs to focus on the direction and magnitude of relations between risk management tools and groupings of risk sources, as correlations are not an indicator of what we essentially need to understand, i.e. causality. The cluster analysis in this paper confirms the complex nature of relations between risk sources.

Despite the local geographical scope of this study, the results illustrate the need to broaden our understanding of the multidimensionality of factors that contribute to individual risk attitudes and behavior.

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Appendix

Table A1. Summary statistics of risk management statements for Risk Attitude Scales

Statement	Risk group	Crop producers			Livestock producers		
		mean	stdev	CISC	mean	stdev	CISC
1. Only a small share of my crop production is acceded to a quality program.	EM	3.64	1.64	0.397	3.83	1.53	.315
2. I do not have enough of time to participate in desired social activities.	SQ	2.7	1.33	0.247	3.21	1.17	0.241
3. I do not take great environmental consideration in my production	EP	1.89	0.80	0.238	1.85	0.81	0.311
4. My animals intended for recruitment are not being carefully accustomed to the production system in which they are to be used.	EnvAW	NR	NR	NR	1.88	1.03	0.072
5. I never refill the sprayer over a bio-foundation or over sealed concrete with a re-collection system.	EnvC	2.39	1.52	0.239	1.94	1.25	0.389
6. I do not have thorough and well-documented controls of my crop production.	EP	2.32	1.41	0.30	2.18	1.24	0.241
7. I do not have a lot of commissions in trust.	SA	3.89	1.21	0.109	3.97	1.10	0.01
8. I never call in a veterinarian to my livestock production.	EnvAW	NR	NR	NR	2.88	1.27	-0.085
9. I do not invest in the farm operation to create opportunities for expansion.	EF	3.31	1.36	0.049	2.78	1.22	0.211
10. My farmed acreage is to a small extent overgrown with fall- or winter crops.	EnvW	2.49	0.97	0.104	2.14	1.16	0.01
11. I never spring-plough light soils that are to be planted in the spring.	EnvW	2.78	1.48	0.127	2.67	1.38	0.194
12. I never pay my bills on the due date.	EF	1.32	0.72	0.081	1.57	0.84	0.032
13. I do not participate in study circles and training relevant to my business on a regular basis.	SA	3.5	1.09	0.259	3.32	1.09	0.068
14. I use chemical weed control after fall harvest to a large extent.	EnvC	2.24	1.05	0.013	2.12	1.20	0.185
15. I often spread manure in the fall rather than in the spring.	EnvW	NR	NR	NR	2.71	1.27	0.126
16. I always postpone acquisitions of input factors as long as possible.	EF	2.12	1.21	0.109	2.57	1.20	0.177
17. I do not have a large part of my production on contracts.	EC	2.32	1.43	0.241	3.11	1.50	0.341
18. My animals are to a small extent kept in a free-range system.	EnvAW	NR	NR	NR	2.17	1.32	0.281
19. I do not produce to the highest possible quality even if it means higher costs.	EP	2.66	1.21	0.309	2.48	1.08	0.211
20. I am not well prepared to handle power failures in my livestock production (having for example a back-up system).	EnvAW	NR	NR	NR	2.80	1.60	0.002
21. I have not acceded to a quality program for my animal production.	EM	NR	NR	NR	2.76	1.60	0.281
22. I do not have any organic production on my farm.	EnvC	4.18	1.53	-0.025	3.21	1.89	0.075
23. I do not believe it to be important to take part in social activities.	SA	2.34	1.02	0.246	2.26	0.98	0.284
24. I always use my check account and/or other short-term liabilities to their full extent.	EF	2	1.24	0.065	2.23	1.38	0.078
25. I do not have adequate fire insurance.	EF	1.82	1.35	0.084	1.76	1.28	0.084
26. I am always using a top soil cultivator when spreading liquid manure.	EnvA	NR	NR	NR	2.84	1.73	0.294
27. The barn system used for my animals does not allow for a natural behavior.	EnvAW	NR	NR	NR	1.75	0.84	0.311
28. There is nobody else in the family who has a great interest in agriculture.	SE	3.11	1.49	0.003	2.91	1.53	0.12
30. I do not collaborate to a large extent with other farmers for machinery and other services.	EF	3.11	1.32	0.036	2.75	1.34	0.282
31. I never hire a production extension specialist before taking major decisions in my firm.	EP	3.97	1.12	0.249	3.74	1.15	0.132
32. I never adjust the weed control to the need to a large extent.	EnvC	1.6	0.81	0.162	1.68	0.78	0.277
33. I often use the check account when buying machinery etc.	EF	1.82	1.18	0.132	1.78	1.18	0.092

Table A1 (cont.).

Statement	Risk group	Crop producers			Livestock producers		
		mean	stdev	CISC	mean	stdev	CISC
34. I have sufficient acreage for spreading the manure needed in relation to my animal production.	EnvW	NR	NR	NR	2.79	1.62	-0.007
35. My animals are often sick.	EnvAW	NR	NR	NR	1.33	0.60	0.207
36. My land is situated so that I often gets problems with freezing and/or flooding	EP	1.87	1.06	0.082	1.71	0.99	0.038
37. I do not adjust the crop rotation to minimize the need for chemical control of weeds and noxious insects etc.	EnvC	2.28	0.96	0.155	2.16	1.07	0.245
38. I never hire a machinery service agency to do most of the fieldwork on my farm.	EF	4.39	1.06	-0.116	4.28	0.95	-0.012
39. I have few hobbies outside agriculture.	SA	2.62	1.27	0.124	2.94	1.31	0.158
40. I do not have a low mortality level in my animal production.	EnvAW	NR	NR	NR	1.60	0.91	0.128
41. A large part of my machinery is old and less well maintained.	EP	2.33	1.15	0.058	2.34	1.20	0.193
42. It is not likely that a close relative will continue to farm my operation when I retire.	SE	3.15	1.41	0.064	3.30	1.38	0.209
43. I do not have green courses (grass) that are not fertilized or being sprayed adjacent to my fields.	EnvB	3.09	1.49	0.239	3.06	1.55	0.304
44. There is no large town or city area with shops, schools and grocery store within a fairly close distance from my farm.	SQ	1.9	1.25	0.272	1.77	1.11	0.048
45. I, and my family never invest a large part of our income outside the agricultural firm.	EF	3.33	1.21	0.213	3.78	1.09	0.139
46. I often spread urine and liquid manure using a broadcasting system.	EnvA	NR	NR	NR	2.97	1.58	0.162
47. I have no employees or other temporary help covering in case of illness.	SE	3.1	1.55	0.003	2.42	1.44	0.178
48. I never take results from soil mapping into consideration when fertilizing with phosphor or calcium	EnvW	2.60	1.39	0.113	2.56	1.22	0.072
49. I never think that I have a good chance to influence decisions concerning the future of my firm.	SI	2.24	1.28	0.116	2.27	1.26	0.106
50. I never leave a zone (at least 6 meters (18 feet)) free from spraying next to the border of the field where grain is grown.	EnvB	3.09	1.44	0.287	3.20	1.52	0.264
51. I have all manure from my stable as non-liquid manure.	EnvA	NR	NR	NR	3.46	1.70	-0.174
52. My animals never have plenty of litter where they lie to rest.	EnvAW	NR	NR	NR	1.52	0.83	0.204
53. I never adjust the amount of nitrogen given to crops to the actual need.	EnvW	1.77	0.96	0.144	1.71	0.87	0.184
54. I have crops that dominate the crop rotation from year to year.	EP	2.58	1.17	0.032	2.40	1.22	0.056
55. There are not many year-around residents in the local area.	SQ	1.79	0.91	0.105	2.01	1.08	0.109
56. I do not have an adequate life insurance.	EF	2.04	1.21	0.042	2.06	1.28	0.306
57. I never have much larger capacity to store manure than necessary.	EnvW	NR	NR	NR	2.42	1.23	-0.002
58. I never test the function of the sprayer on a regular basis.	EnvC	2.35	1.29	0.238	2.19	1.39	0.547
59. I do not have an adequate insurance for accidents.	EF	1.77	0.91	0.23	1.86	0.94	0.192
60. I never perform an analysis of the nutrient status of the manure to be used in the fields.	EnvW	NR	NR	NR	3.36	1.66	0.043
61. I would like to collaborate more with other farmers (using machinery, buying input supplies etc.).	SI	2.92	1.32	-0.052	2.85	1.37	-0.009
62. I do not have a thorough and well-documented supervision of my animal production.	EP	NR	NR	NR	1.99	1.27	0.231
63. I never mull manure that has been spread within four hours.	EnvA	NR	NR	NR	3.09	1.29	0.203

Table A1 (cont.).

Statement	Risk group	Crop producers			Livestock producers		
		mean	stdev	CISC	mean	stdev	CISC
64. I do not have good contact with other farmers to discuss firm related issues.	SE	2.78	1.16	0.218	2.67	1.27	0.022
65. I use barbed wire to a large extent.	EnvAW	NR	NR	NR	2.68	1.39	0.073
66. I have a crop production which to a large extent not allow for minimum tillage practices.	EnvW	3.08	1.28	0.054	3.38	1.25	0.265
67. I do not have a substantial amount of green courses surrounding lakes and watercourses.	EnvB	3.08	1.60	0.264	2.91	1.44	0.364
68. In the case of emergency, I would have problems finding sufficient back-up with short notice to carry out my production practices.	EP	2.88	1.23	0.07	2.65	1.48	0.187
69. I never have enough of cash or liquid funds to pay invoices or credits.	EF	2.02	1.31	0.143	2.27	1.25	0.182
70. I never use the wind- and field standards for use of chemicals set by the “Safe crop protection” program.	EnvC	1.68	0.71	0.156	1.73	0.81	0.307
71. It is not important to me to maintain a low debt-to-asset ratio.	EF	1.83	1.07	0.008	1.80	1.02	-0.101
72. I never discuss issues related to my farm operation with professional advisors.	EP	3.32	1.23	0.161	3.07	1.24	0.096
73. I never use catch crops when possible.	EnvW	4.08	1.08	0.003	3.63	1.18	0.184
74. I never fall plough as late as possible.	EnvW	2.88	1.14	0.058	2.27	1.07	0.092
75. I do not have very good contacts with my neighbors.	SE	1.86	0.96	0.124	1.62	0.79	0.148
76. I do not combine high efficiency in production with high standards of animal husbandry.	EP	NR	NR	NR	1.76	0.81	0.296
77. I always spread manure before sowing in the fall.	EnvW	NR	NR	NR	3.40	1.39	0.002
78. I never adjust means of control for fungicides and noxious insects to actual needs to any large extent.	EnvC	1.75	0.96	0.079	1.78	0.91	0.094
79. I never break ley in late fall or early spring.	EnvW	NR	NR	NR	2.76	1.37	-0.092
80. I do not place great trust in printed information or information available on the Internet that is used for operational decision making in my firm.	EP	3.52	1.25	0.236	3.45	1.12	0.113

Note: i) Statements with bold number had this wording in the questionnaire. The other statements were presented with a reversed wording. ii) NR denotes not relevant. iii) Respondents were asked to attribute an integer number between 1 and 5 to each statement 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree. The correspondence between numbers and their verbal interpretation were presented to the respondents in the questionnaire. Each statement had also an opt-out alternative, which was denoted “not relevant”.