Modelling risk-based inspections in EU organic certification: data requirements and analysis tools

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Abstract

A Risk Based Inspection (RBI) scheme is a planning tool used to develop the optimum plan for the execution of inspection activities. Organic certification system could benefit from the implementation of RBIs in terms of higher effectiveness, i.e. trustability, and lower transaction costs for organic operators. Data from certification bodies provide basic information about non-compliances and structural aspects of organic operators. Here we propose a methodological approach to risk analysis modelling, based on discrete choice models and Bayesian networks, both aiming at the identification of key risk factor in the organic certification process in the European Union.

Introduction

The goal of Risk Based Inspections (RBIs) is to develop a cost-effective inspection and maintenance programme that provides assurance of acceptable integrity and reliability. RBIs use the findings from a formal risk analysis – according to defined criteria - to guide the direction and emphasis of the inspection planning and the physical inspection procedures. A risk-based approach to inspection planning in the organic certification system should consider two aspects: the improvement in the analysis of the probability of a fraud or non-compliance to be detected, and the economic evaluation of a higher efficiency and effectiveness of the certification system.

Here we particularly focus on the first aspect, and discuss some methodological proposals based on discrete choice models and Bayesian networks (BN) to analyse the probabilities of non-compliances with respect to the rules and regulation of the organic farming practices. The aim is to provide tools to support inspections and to focus efforts onto the most critical categories of organic operators, both farmers and

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processors. The implementation of a codified RBI approach becomes particularly relevant if it can be harmonised at the level of general elements a system should contain, and then applied to certification systems of different countries. Therefore we also discuss some relevant issues concerning the availability of standardised control data from the European organic certification bodies.

Materials and methods

In operative terms, modelling harmonised RBIs for the organic system means to explain the probability of detection of non-compliances conditional to a set of risk factors, or variables. Two aspects are therefore involved: a harmonised dataset of relevant information for organic certification systems, and a set of methods to properly assess relevant risk functions. For what concerns the first aspect, from the perspective of a harmonised RBI a first crucial issue is that the central term non-compliance is not clearly defined in the EU regulation. Non-compliances are classified as irregularities and infringements (REG 2091/91) though no explicit definition is provided. From the analysis of REG 834/2007, however, we can conclude that irregularities refer to non compliances concerning documental/formal aspects and temporary violation of Reg 834/2007, while infringements refer to non compliances concerning violation with long term effects (also documental/formal). In this research we have collected data from certification bodies in Italy, Denmark, Germany, Switzerland, Check Republic and United Kingdom. A wide range of structural variables are available for each country, like land area, livestock, type of crops etc, and they have been homogenised as well, using Eurostat classifications where applicable.

Results

Information on non compliance and related sanctions is stored by control bodies of each country according to different definitions and schemes, and no detailed information on the type and severity of non compliances encountered is available in an electronic format for all of them. Therefore, we have used the type of sanctions, for which data are available in detail, as an indicator of relevant non-conformities and of their degree of severity. Following the approach of Accredia (Italian accreditation body) for defining which sanction shall be associated to each type of non compliance, and thanks to the support of ICEA and IMO qualified staff, we have provided a homogenised classification of sanctions for all countries, and have grouped similar sanction types into four classes, corresponding to irregularities and infringements (Tab. 1).

Tab. 1 Scheme for homogenisation of sanctions and non-compliances

		Nr of country specific sanctions types					
Homogenised sanction type	Type of non compliance	CH	CZ	DE	DK	IT	UK*
Slight	Irregularities	5	1	3	4	1	1
Moderate		4	1	1	3	1	1
Severe	Infringements	5	1	1	3	1	1
Extreme		2	1	2	2	2	1

* Non-compliances

Note that for UK no data on sanctions are available, but differently from other countries, non-compliances are codified in terms of severity, which allowed us to use the same classification used for sanctions, though of course they are not directly comparable. A common database has been produced, merging data from each country, that includes 84386 operators, both pure farmers, pure processors and mixed farmer/processors. The database contains more than 900 variables, though with many missing values as not all data are available for all countries. Structural variables have been used to specify hypotheses concerning relevant risk factors, which can be summarised as indicated in Tab. 2.

Tab. 2 Variables hypothesized to be related to risk factors

Risk factor category	Variables
General risk aspects (all operators)	Operators who got sanctions in the past; operators with other certification schemes; operator experience as organic
Structural/managerial aspects (farmers)	Size (UAA, Livestock units), size related indexes (e.g. UAA < 10 ha), processing activity, non organic land/livestock, production complexity (e.g. number of crops/species), crops and livestock types (Eurostat classification)
Structural/managerial aspects (processors)	Number of products, turnover, farming activity, product types.

Discussion

In terms of RBIs, we are interested to assess the probability of detecting non-conformities when a set of "risk variables" takes specific values. Different results can be obtained: an impact evaluation of single risk factors, and the impact evaluation of different combination of variables (farm types) jointly considered. The aim is to discriminate between low and high-risk operators. Discrete choice models (particularly Logit and Poisson models, cf. Greene, 2008) and Bayesian networks (Horvitz *et al*., 1988, Jensen 1996) are used to model non-compliances probabilities.

Logistic models estimate the probability of a sanction to be detected ($Y=1$), given a set of explanatory variables $\mathbf{x}$ and a set of coefficients β, as:

$$prob(Y = 1 \mid \mathbf{x}) = \frac{e^{\mathbf{x}'\beta}}{1 + e^{\mathbf{x}'\beta}}$$, hence considering a binary probability

while Poisson models estimate the probability of detecting a discrete number of sanction ($Y=y_i$) as follows:

$$prob(Y = y_i \mid \mathbf{x}_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!}$$, where $\ln \lambda_i = \mathbf{x}_i'\beta$

BNs have an alternative approach based on conditional probabilities and can be interpreted as a model of the interactions among a set of variables, where each variable has a finite set of mutually exclusive states. Information about the actual state of one or more variables (evidences) can be used also to evaluate the probabilities of different variable configurations, i.e. to simulate what the probability of a specific state of the network would be. For instance, given two variables A and B, and an evidence

set e, BNs can compute the probability that A and B assume respectively the states a, b:

$$prob(A = a, B = b \mid e) = \frac{prob(A = a, B = b)}{prob(e)}$$

The econometric approach allows testing statistically the relevance of risk factors, and their impact on the probability of non-compliances, while the BN approach provides an estimate of the impact of different combinations of risk factors on the probability of non-compliances.

Conclusions

Harmonised RBI is crucial to guarantee integrity, improve efficiency and reduce the cost of inspections: a growing body of small “organic” farmers and growers are refusing certification and inspection schemes and selling on alternative short supply-chains – this creates further confusion among consumers. A set of econometric and statistical tools allow to identify the critical risk factors to be considered for detecting non compliances, hence providing a scientific support to the focussing of control activities towards more risky cases. Such modelling approach requires however a great effort in data collection and harmonisation. Clear and uniform criteria for classifying non-compliances and better data and information systems are required to successfully implement RBIs on a larger scale.

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