MODELLING OF CERTIFICATION SYSTEMS

REPORT ON ECONOMIC MODELLING RESULTS AND ACTIONS TO INCREASE EFFICIENCY AND COST-EFFECTIVENESS OF INSPECTION PROCEDURES

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27.01.2012

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This report presents findings of an analysis of the risk of non-compliance and sanctions in the organic certification system in Europe.

Non-compliance risk factors and explanatory modelling were analysed referring to case studies in six European countries and a case study in Turkey.

Based on the empirical results and theoretical evaluations, recommendations are made for actors and stakeholders in the organic sector.

DISCLAIMER

This publication was generated as part of the CERTCOST Project, agreement no. 207727 (http://www.certcost.org), with financial support from the European Community under the 7th Framework Programme. The publication reflects the views of the author(s) and not those of the European Community, who is not to be held liable for any use that may be made of the information contained.

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List of abbreviations

CB ....Control body
CH ....Switzerland
CZ..Czech Republic
DE ....Germany
DK ....Denmark
EUROSTAT ....European statistics
FMEA ....Failure Mode Effects Analysis
GMO..Genetically modified organism
ICEA ....Ethnical and Environmental Certification Institute
IT ....Italy
JAS..Japanese Agricultural Standard
LU..Livestock Units
NACE ....The National Association of Corrosion Engineers
NC ....Non-compliance
NOP...National Organic Program
RBI ....Risk Based Inspections
TR..Turkey
UK ....United Kingdom

EXECUTIVE SUMMARY

A more efficient certification system may contribute significantly to increase organic product competitiveness while still maintaining the benefits of trustworthy organic labelling. This goal can be achieved by developing a cost-effective inspection programme that provides assurance of acceptable integrity and reliability, hence shifting the organic certification system more towards a risk based strategy. Risk-based inspections systems 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 non-compliance to be detected, and the economic evaluation of a higher efficiency and effectiveness of the certification system. In operative terms, modelling risk-based organic inspections systems means to relate the probability of detection of non-compliances 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 appropriate methods to properly assess relevant risk factors.

In this research we have analysed data from control bodies in Czech Republic, Denmark, Italy, Germany, Switzerland, Turkey and United Kingdom. The data cover characteristics of organic operators (i.e., farms and processors) and their production as well as the characteristics and results of organic control visits on the years 2007 to 2009. The data are not representative for the respective country but have to be interpreted as a case study.

EXECUTIVE SUMMARY

A crucial issue for a common dataset with information about non-compliances across Europe is that the central term “non-compliance” is not precisely defined in the EU regulation. Though we are mainly interested in the determinants of non-compliance, we found the data on sanctions to organic operators more easily available, and better structured than the data on non-compliances in most of the control body data analysed for this report. In five cases, we used sanctions as a proxy variable for non-compliance in the model calculations. Only for the UK control body we used non-compliance data which were sufficiently classified according to the severity of non-compliance and because no sanction data were available.

Data have been analysed with a range of methodological approaches aiming at the analysis of the issue of risk from different perspectives: the factors determining the risk of sanctions (CH, DE, DK, IT) and non-compliance (UK) were analysed using econometric modelling, probabilistic networks for the definition of expert systems, and heuristic models for the interpretation of operators’ behaviours and inspection strategy optimisation (due to incomplete data, no statistical analysis could be done for CZ).

The aim was to provide tools to support the inspection system and to focus efforts onto the most critical categories of organic operators, both farmers and processors. The implementation of a rule-based, risk-based inspection system approach becomes particularly relevant if it can be harmonised at the level of general elements that a system should contain, and then adapted and 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 control bodies.

The report briefly outlines the data source, methods and results, but the focus lies on key conclusions and recommendations for different actors in the organic sector with regards to the implementation of an effective certification system for the organic sector in Europe.

In all countries, and for farmer and processor data, the occurrence of non-compliances is critically affecting the risk of further non-compliant behaviour.

For farmers only, other operator-specific data such as farm size and complexity of operations showed a significant increase of risk in all countries.

We did not find any specific crops affecting risk in all the investigated countries, but there is evidence that livestock operations in general and pigs and poultry in particular increase the risk of non-compliance.

The main implications emerging from the analysis refer to three issues.

1. A harmonised definition of sanctions and non-compliances across countries is essential. This harmonisation is a critical pre-condition for the implementation of a common approach to risk evaluation, and to assure that non-compliances and sanction are defined similarly in all EU countries. An attempt for this type of standardisation is proposed and discussed.
2. The data collected by control bodies are particularly detailed with respect to structural aspects, but not with respect to personal information about the operators. For example, there are very detailed crop classifications but very little information on the farms/processors (e.g. age of farmer/processor when family enterprise, total turnover, liabilities and debt, solvency, etc.). This is a

structural limitation that could affect the effectiveness of risk-based inspections systems; evidence for this issue is provided, together with suggestion for the extra information necessary.

3. Finally, the general approach of risk evaluation is based on the evidence of detected non-compliances and sanctioned non-compliances. Detected non-compliances are likely to be only a share of the total non-compliances actually, since “underreporting” is likely to be in place in any inspection system: inspectors do their best to detect non-compliances but some may well remain undetected. On the other hand, at least hypothetically, not all detected non-compliances will correspond to a sanction. Because much of the quantitative analysis is based on sanctions (as a proxy for non-compliance) the resulting shortcomings suggest some caution in the interpretation of the results.

1. INTRODUCTION

1.1. Background

Certification is a key element of organic farming systems today, as only certified organic products may be labelled as such, thereby gaining access to the organic market and possibly earning premium prices (Dabbert et al., 2008). The organic certification system allows consumers to recognise organic products, and to assure that they are actually produced according to specific rules. It represents therefore a crucial tool to differentiate organic products, and to generate competitive advantages for organic producers. Non-compliance with the EU-regulation should be avoided because it is likely to jeopardize the trust of consumers. However, certification systems also generate transaction costs that are only specific to organic producers and might reduce their competitiveness with respect to non-organic competitors. Therefore, an improvement in the efficiency and effectiveness of the organic certification system might contribute to improve the general competitiveness of the entire organic sector.

The goal of risk-based inspections is to develop a cost-effective inspection and maintenance program that provides assurance of acceptable integrity and reliability of a control system.

A risk-based inspection management for the organic certification system could produce substantial benefits in many areas:

- reduce the risk of non-compliance as low as reasonably practicable; optimise several the inspection schedules;
- focus inspection efforts onto the most critical areas;
- and identify the most appropriate methods of inspection.

Cost effectiveness in particular can be achieved with a more effective planning of the inspection scheme. Such planning can use the probability of non-compliance as key input. With this approach, it would be possible to concentrate resources to operators with a higher risk of non-compliance.

1.2. Objectives

The main objectives of the modelling of certification systems within the CERTCOST project are:

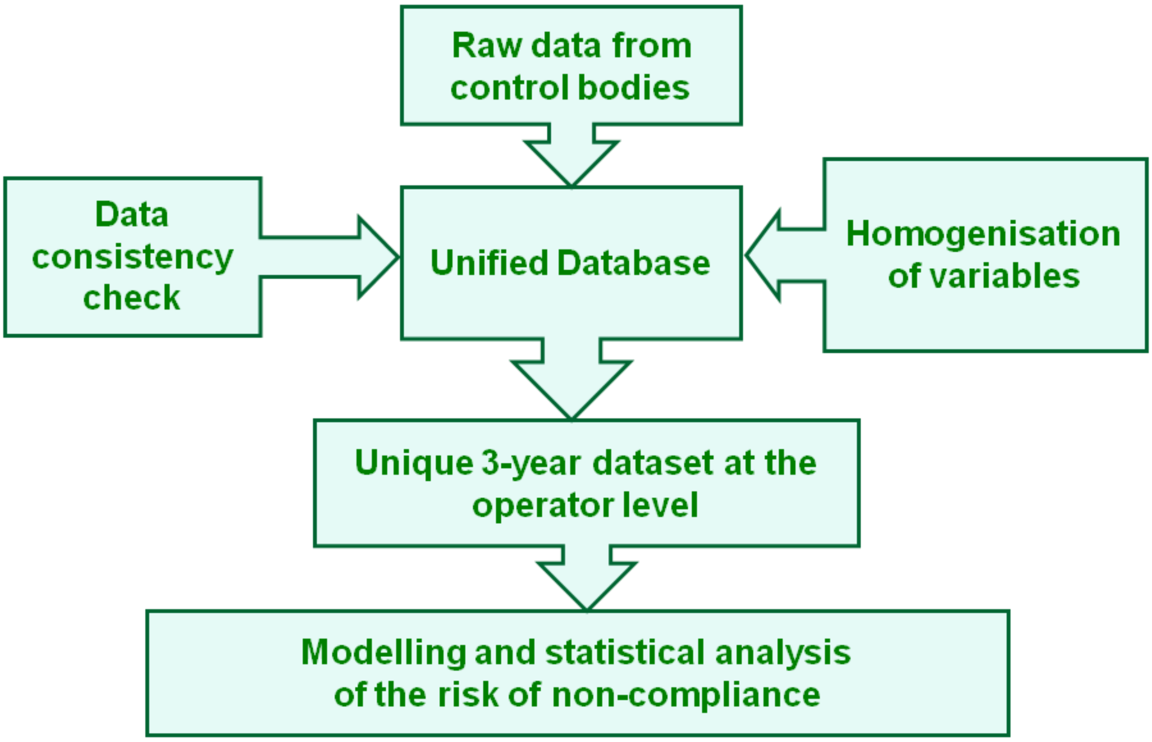
1. Assessment and description of the current inspection practices in terms of risk and efficiency
2. Development of a risk based model (based on probability theory) that can be used to increase the efficiency of the inspection and certification system
3. Optimisation of enforcement measures designed to reduce the occurrence of non-compliances in organic production (e.g. the proportion of faulty products)

In order to address these objectives, we have pursued a methodological approach based on a probabilistic risk modelling. The basic idea was to look for patterns relating the number of non-compliances detected to a number of variables characterising the organic operators and their operations. In practice, we were looking for farmer/operator-specific and farm/firm-specific factors that are more likely to be associated with non-compliances.

The countries from which data were used in the analysis were: Switzerland (CH), Germany (DE), Denmark (DK), Italy (IT), Turkey (TR), and United Kingdom (UK).

The scheme in Figure 1 summarises the general procedure followed for the analysis.

Figure 1: Scheme for the analysis of the risk of non-compliance



Source: Own scheme.

In order to predict the risk of non-compliance at farmer/operator level we needed data on:

- detected non-compliances;
- structural, financial and managerial information at operator level.

These data were extracted from the individual databases of a number of control bodies in Europe. Since control bodies collect data for inspection and certification purposes according to the EU regulations, but a common EU standard for data storage does not exist, we had to perform a number of consistency checks and data transformations in order to standardise the variables, and make them usable for further analyses. Since there are no detailed regulations on the implementation of organic controls, control bodies differ in their practice and this is reflected on data, too. Indeed, a preliminary quantitative case study on German supervision data of the organic control system revealed significant differences between control bodies with regard to severe sanctions imposed, control frequencies and share of unannounced controls (Zorn et al., 2012a).

Three analytical tools were used in our analyses. In the first instance we performed an econometric analysis, in order to make inference regarding the probability of different types of non-compliances using the available data on farmers/operators and farm/firm characteristics as explanatory variables. This analysis was complemented by Bayesian network modelling: a knowledge discovery approach was applied to the data in order to identify the relevant risk factors jointly explaining the risk of non-compliance. Finally, a heuristic model of the certification system was developed to capture the main factors determining non-compliance, related damages, as well as compliance costs, and transaction costs of certification.

The implementation of risk-based inspection systems in organic certification may be based on simple, heuristic rules derived from our results. For example the risk-based system applied by production engineers named Failure Mode Effect Analysis (FMEA) (McAndrews and O'Sullivan, 1993), could be adapted to the planning of the organic inspection system.

In this report we present the results of various statistical analyses and modelling, and we attempt to identify actions to increase the efficiency and cost-effectiveness of inspection and certification procedures. The latter constitutes recommendations to stakeholders and policy makers concerning the implementation of effective risk-based inspection systems.

1.3. Acknowledgements

The research presented in this report was generated as part of the CERTCOST project with financial support from the European Community under the 7th Framework Programme. We acknowledge the contributions to all stages of the empirical research from the CERTCOST project partners, especially those from Samanta Rosi Bellière from the Institute for Ethical and Environmental Certification (ICEA), Elisabeth Rüegg from the Institute for Marketecology (IMO), Heidrun Moschitz, Matthias Stolze, and Franco Weibl from the Research Institute of Organic Agriculture (FiBL), Bülent Miran, Murat Boyaci, Canan Abay and Özlem Karahan Uysal from EGE University, and Susanne Padel from the Organic Research Centre Elm Farm. We also wish to thank Viola Bruschi from the Università Politecnica delle Marche for help in processing the Turkish data and Marco Huigen from University of Hohenheim for help in fine-tuning the database.

2. DATA

2.1. Data collection

The data used in this research have been extracted from the standard inspection databases of the following six data providers in seven European countries including Turkey: Bioinspecta (CH), Control of Organic Farming - KEZ (CZ), Institute for Marketecology - IMO (DE & TR), Danish Plant Directorate/Danish Veterinary and Food Administration (DK), Institute for Ethic and Environmental Certification – ICEA (IT and TR), Soil Association (UK). We used standard data that are routinely recorded by control bodies, in order to examine the possibility of developing risk-based inspections based on these data: no extra information was requested. Data were obtained for the years 2007, 2008, and 2009 and covered all operators that were in the control bodies` datasets at the time: each operator was given a unique but anonymous ID code over the whole period (Moschitz et al., 2009).

A 'wish-list' of variables was produced at an early stage of the research by all partners involved, and was forwarded to data providers. The main focus variables were non-compliances and related sanctions, plus a number of potential explicatory variables that we thought could be relevant. The data were provided centrally to one partner (FiBl) for basic consistency checks and data standardisation and for inputting into a common database. A consistency check aimed to evaluate how data from a given source compare with some generally known or accepted characteristics of the data. The internal consistency of data involves an investigation of the extent to which the data can be taken as logically related to each other (Zarkovich, 1975). For example, the sum of area under various crops cannot exceed the total arable land.

Another important check is the analysis of extreme observations or outliers, because often they simply hide some error in data input (e.g. too many or too few zeros).

Since data came from different sources and countries, a standardisation of labels and variable definitions across sources/countries was also needed.

For what concerns farm data, the EUROSTAT coding for structural, crop and livestock data was taken as a reference. The NACE classification[1] was used to classify industry and products for processor data.

Data on detected non-compliances was one of the most important variables to model risk-based inspection. Unfortunately, the data providers do not have a univocal way of recording and classifying these data. Therefore, the comparability of data from different sources is limited, unless a proper appraisal of the extent of agreement of data from these different sources is performed. In the Regulation (Council Regulation 834/2007) non-compliances are indirectly referred to as irregularities and infringements, and it is made clear that the former are less severe than the latter, but no explicit definition is provided. Furthermore, non-compliance information was not available for all control bodies and all years (e.g., for ICEA-Italy non-compliance information was not recorded in the database until 2010). Where available, data were not always coded in a way that could allow an univocal identification of the degree of severity of the respective non-compliances (e.g. the German CB recorded non-compliances with textual descriptions that refer to the breached article of the Regulation, but this not always allows to infer the degree of severity; the Swiss CB recorded non-compliance as described by each single inspector in his/her own words). Only in the UK the CB recorded and classified non-compliances according to their degree of severity, distinguishing between minor, major, critical and manifest[2] non-compliances.

However, most control bodies recorded sanctions in a similar way and this information could easily be ranked according to their severity. The UK CB did not record data on sanctions at all, but – as mentioned above – the non-compliances were classified according to the degree of severity.

In Turkey, the database is structured differently compared to most of the other countries. Very detailed structural and crop/livestock data are collected for each farm and stored in a central governmental database called ‘Otbis’. The sanction scheme allows for distinguishing between irregularities and infringements, but only severe sanctions are recorded in the control body database. A positive result in sample testing – if confirmed – always leads, as a consequence, to the ‘suppression’ of the single product lot from certification; in extreme cases, the non-compliance leads to

[1] The Statistical Classification of Economic Activities in the European Community (in French: Nomenclature statistique des activités économiques dans la Communauté européenne), commonly referred to as NACE, is the European industry standard classification system.

[2] Soil Association did not record ‘manifest’ non-compliances in the database. All ‘critical’ non-compliances have to be reviewed by the certification committee and that decides on severity of the non-compliance (critical or manifest) and the appropriate sanctions. In our analysis, the ‘severe’ category is used for all critical non-compliances.

the exclusion of the individual farmer or of the whole 'legal company' from certification.

In order to proceed with the analysis, we therefore assumed that a severe sanction is issued when a severe non-compliance (also known as infringement) is detected, and a less severe sanction is issued in response to a correspondingly less severe non-compliance (also known as irregularity). In other words, sanctions have been used as a proxy of non-compliances for all CBs (except UK-CB), which mean that we assumed that non-compliances have been followed by sanctions, with the appropriate level of severity.

Besides, we had to proceed to standardise sanction data across control bodies, as they do not follow a common sanction scheme. A standardisation of coding was implemented for CH, CZ, DE, DK, and IT. The sanctions were classified either as 'slight' or 'severe', in order to keep reference to irregularities and infringements as mentioned in the European Regulation. The sanction scheme agreed upon by all control bodies in Italy, served as the basic framework for the standardisation and recoding of sanctions. This is based on a clear correspondence between sanctions and non-compliances, and structured around a limited number of sanction types (Accredia, 2009). The Czech sanction structure is very similar to the Italian one, while Swiss, German and Danish data exhibit a higher number of sanction types. These were aggregated according to the severity of non-compliance they refer to (see Table 1). At this stage the expertise from the CERTCOST partners from the certification sector has played a crucial role. In UK, in accordance with the practice used by the data provider, we grouped minor and major non-compliances together and considered them as 'slight' (i.e. irregularities), while 'severe' was used for all critical non-compliances recorded in the database. The structure of the Turkish data on non-compliance and sanctions is quite different and could not be harmonised with the data from the other countries: we simply distinguished among sanctioned and not sanctioned farmers. The TR data refer only to severe sanctions, since only these are recorded in the available database. Table 1 provides information about the different numbers of original sanction types that are behind the two harmonised sanction categories. The situation across countries is quite different, with CH and DK showing a higher number of sanction types, while IT, UK, and DE sharing a more similar sanction structure.

Table 1: Number of sanction types by standardised sanction category

Standardised sanction category	CH	CZ	DE	DK	IT
Slight sanctions	7	2	4	7	2
Severe sanctions	10	2	3	6	3
Total sanction types	17	4	7	13	5

Source: Own calculations based on the CERTCOST data base.

After these preliminary data quality checks and sanction coding, a complete restructuring of the data was needed, in order to make the database usable for statistical analysis. Also further tests were performed on the data in order to avoid modelling problems. Missing data were recorded in a consistent way in order to avoid confusion with zero values of the variables; duplicate entries were removed, in order to produce the final dataset. From this dataset, analyses were performed at the level of each control body, since the availability of data and the data structure suggested not to pool the data together. All statistical analyses were performed only on farm data. However, Czech farm data were originally considered in the analysis but due to the lack of structural data at the farm level, no risk analysis could be performed for this country. The availability of data on processors was generally quite limited, so we could only perform a pilot study on the Italian and UK CB data.

As key indicator for the risk evaluation process, we have used the number of sanctions, except UK where we have used actual non-compliances. In the remainder of this report we will simply refer to modelling the risk of non-compliance, even when sanction data are involved, unless the distinction between the two is necessary to avoid confusion for the reader.

2.2. Occurrence of non-compliances in the data sets

Table 2 shows the distribution of farms by standardised non-compliance categories across control bodies and years. The difference in the frequencies – as obtained from our sample data – is quite remarkable. In the case of the German and UK control body around 40% of the farmers are sanctioned in a year. For the control bodies located in CZ, and IT and for the Danish Control Authority, in contrast, the share of farmers sanctioned is well below 10%. The difference mainly results from many slight sanctions imposed on German organic farms by the control body investigated.

Table 2: Distribution of farms, by standardised sanction/non-compliance category, country, and year

Country	Year	Farms with slight sanctions (UK: non compliances)		Farms with severe sanctions (UK: non compliances)		Total number of farms
		n	Percent	n	Percent	
CH	2007	73	1.6	191	4.1	4,661
	2008	57	1.2	145	3.2	4,508
	2009	77	1.8	116	2.6	4,388
CZ	2007	6	0.8	0	0	700
	2008	12	1.6	0	0	740
	2009	84	10.5	7	0.8	877
DE	2007	776	48.9	35	2.2	1,584
	2008	799	47.4	29	1.7	1,686
	2009	794	37.0	15	0.7	2,145
DK	2007	156	6.0	20	0.8	2,589
	2008	175	6.6	32	1.2	2,654
	2009	51	2.0	14	0.6	2,505
IT	2007	767	8.1	103	1.1	9,398
	2008	572	6.1	198	2.1	9,351
	2009	533	5.0	200	1.9	10,732
UK	2007	663	40.5	16	0.9	1,820
	2008	913	47.2	14	0.7	2,151
	2009	853	45.8	48	2.2	2,155
TR*	2008	-	-	574	20.0	2,871
	2009	-	-	794	18.8	4,213

* For Turkey the shown data represent the sum of data provided by ICEA and IMO. The recorded sanctions are all severe.

Source: Own calculations based on the CERTCOST data base.

The distribution of sanctions for the control body located in CH, where more severe sanctions are imposed than slight sanctions[3] is remarkable. The share of farms committing infringements (eventually leading to more severe sanctions) is similar and very low in all countries analysed, ranging from 0 to 4% of the controlled farms. However, the shares of farmers being severely non-compliant change considerably between years in all European countries.

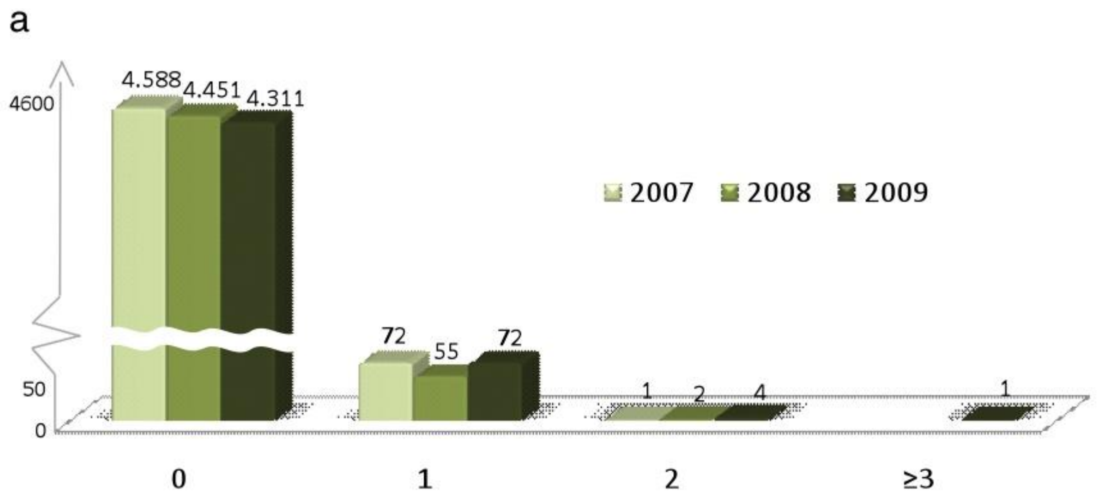
We were also interested in the analysis of the number of sanctions/non-compliances that have been detected per farm. Most of the farms show no sanctions or non-compliances; however sanctioned farms may have received more than one sanction per year. In general, the number of slight sanctions per farm is higher than the number of severe sanctions. The information on the number of sanctions (or non-compliances in the case of the UK data) is specifically exploited by the econometric

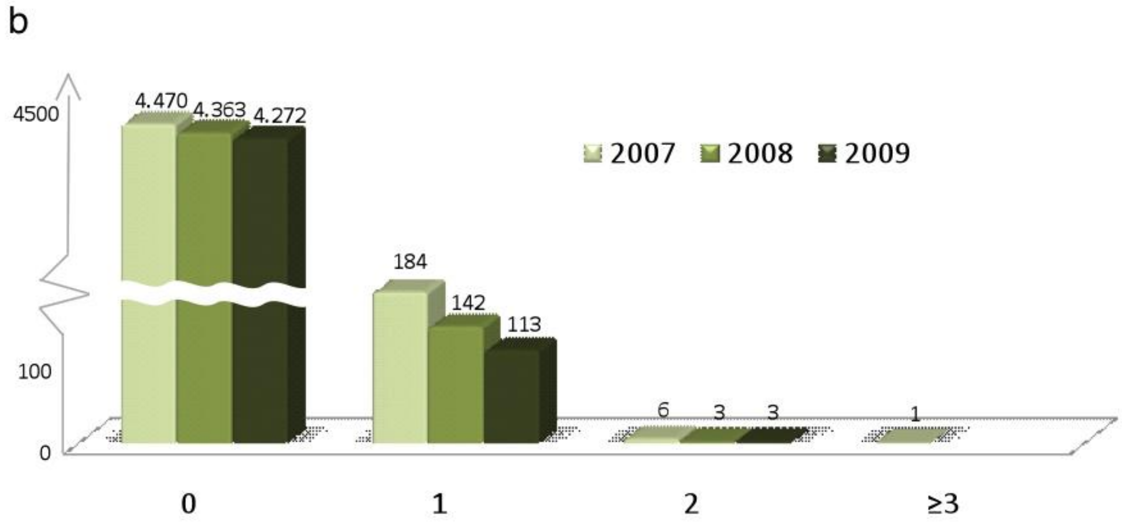
[3] One reason behind the observed distribution of sanctions in Switzerland may be the fact that non-compliances with BioSuisse guidelines often result in 'sanctions on marketing' ("Vermarktungsauflagen") e.g., the duty not to sell a sausage as BioSuisse-organic due to a non-BioSuisse spice used in processing. 'Sanctions on marketing' were classified as sanction 3 (severe sanction), and are occurring quite often.

models used for the analysis of the risk factors. Figures 2 to 7 show the distribution of the number of sanctions by sanction category and country. For the control bodies located in DE, IT and UK the number of operators with more than one sanction/non-compliance is more relevant, and some operators get more than three sanction/non-compliances per year. On the other hand CZ data show a very limited number of severe sanctions only in the last year studied, and in general no more than one sanction is imposed per operator and per year. The Danish control authority issues a maximum of two severe sanctions per operator in each observed year.

The reader should keep in mind that – for simplicity – we refer to countries, instead to the specific data-providing control body in each country, when presenting the results. With the exception of DK, where the certification control authority covers all the organic farms operating in that country, data from the other countries refers only to the specific control bodies that provided the data; therefore, data refer to a share of organic operators in the respective countries, and cannot be considered as representative of the national situations. This should be taken into consideration when interpreting the results of the analysis that refer to specific countries.

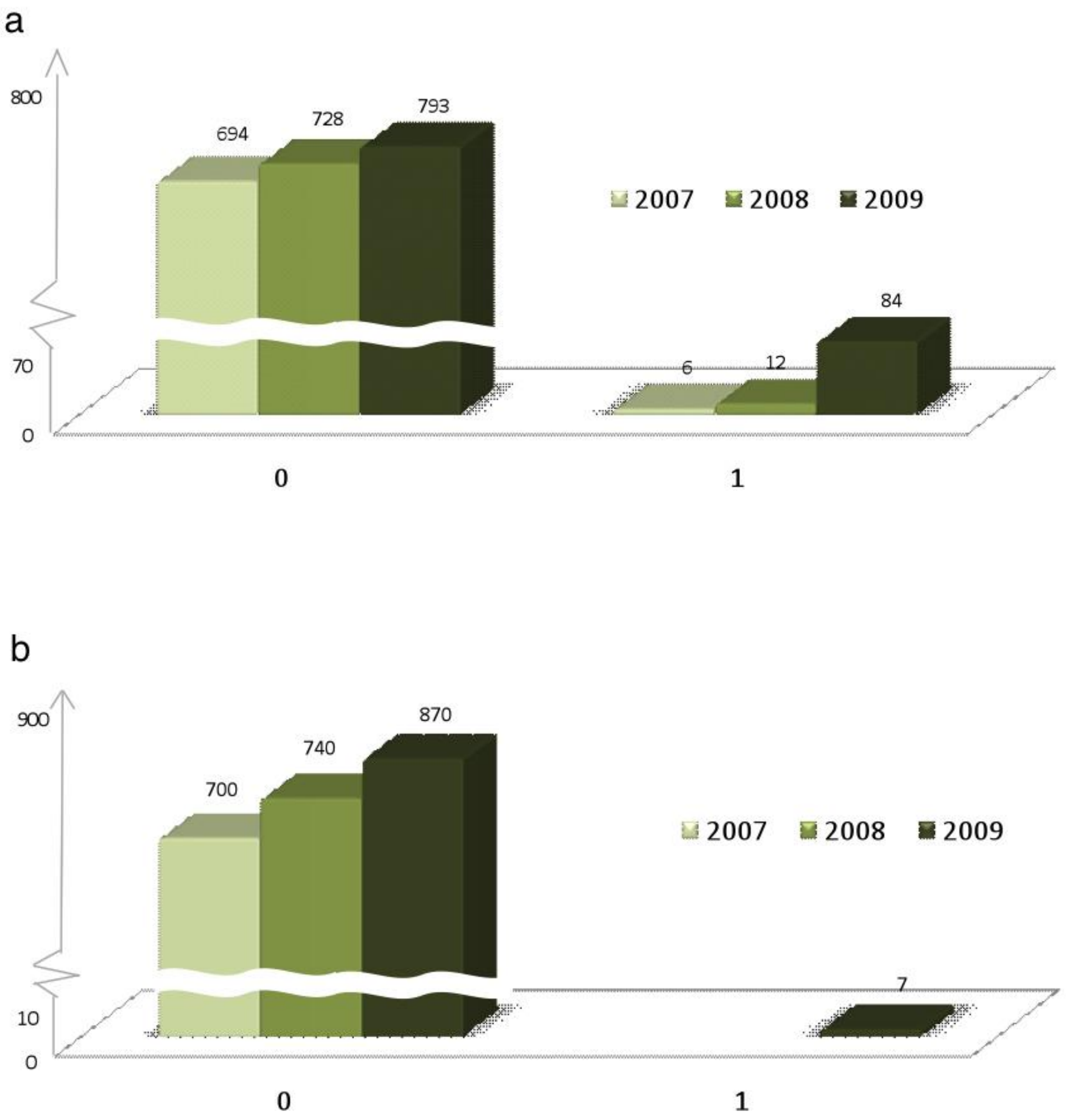
Figure 2: Number of farms by number of sanctions per farm and year; slight sanctions (a) and severe sanctions (b), Swiss control body data





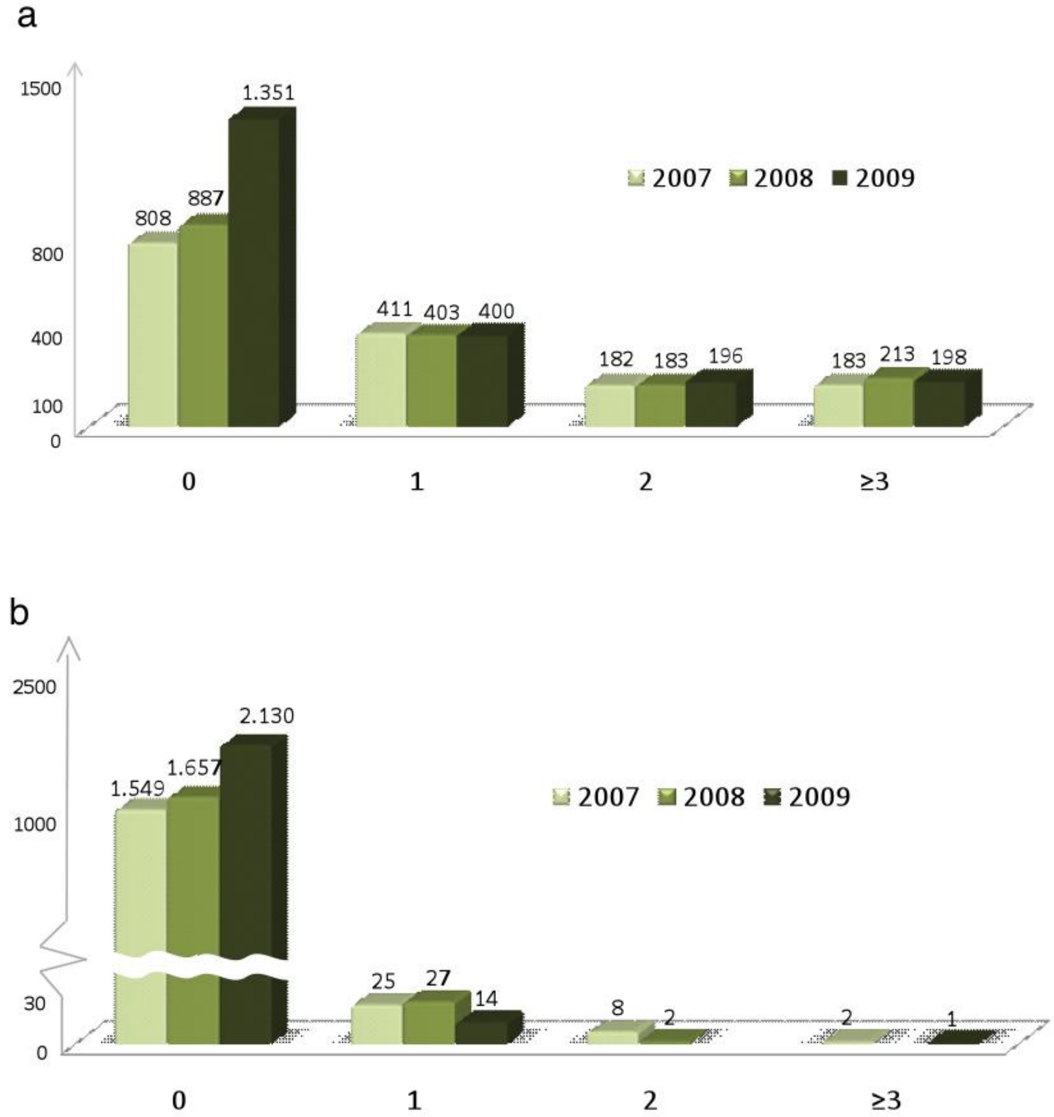
Source: Own calculations based on the CERTCOST data base.

Figure 3: Number of farms by number of sanctions per farm and year; slight sanctions (a) and severe sanctions (b), Czech control body data



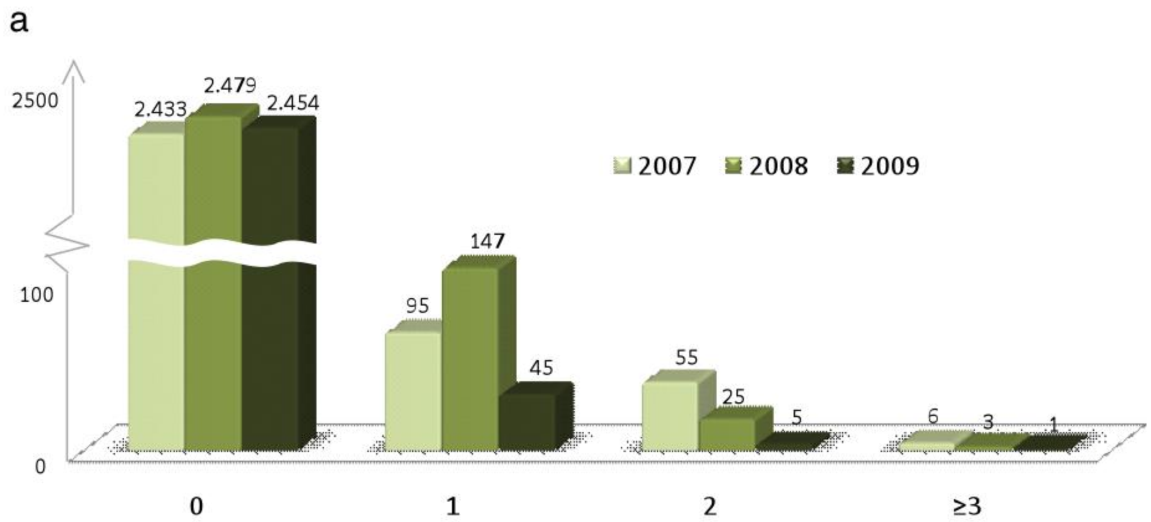
Source: Own calculations based on the CERTCOST data base.

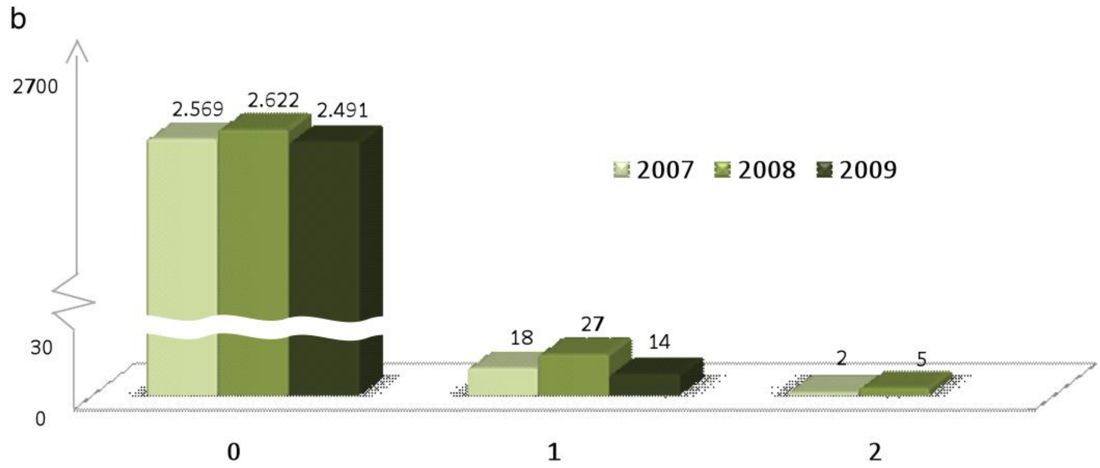
Figure 4: Number of farms by number of sanctions per farm and year; slight sanctions (a) and severe sanctions (b), German control body data



Source: Own calculations based on the CERTCOST data base.

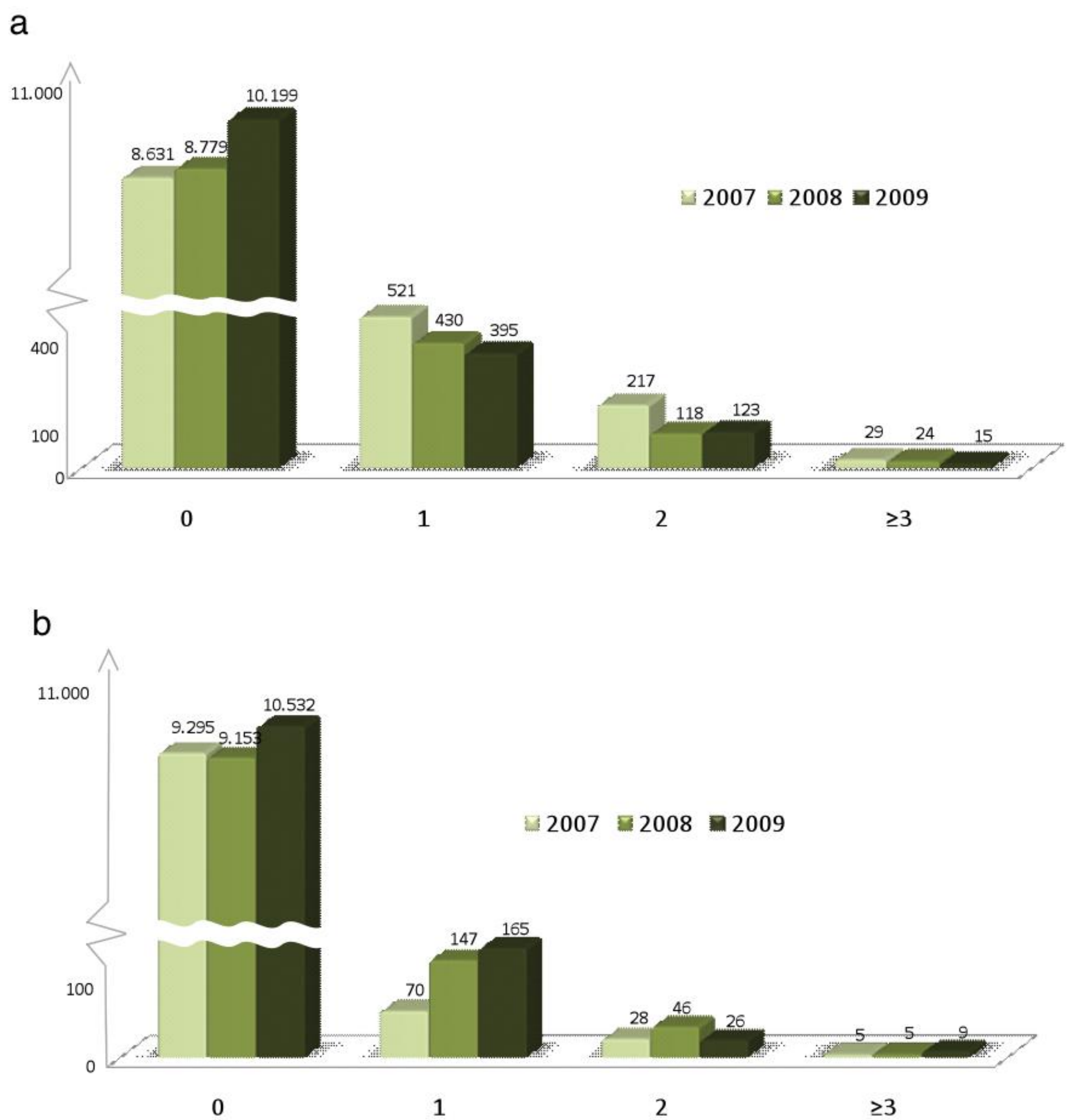
Figure 5: Number of farms by number of sanctions per farm and year; slight sanctions (a) and severe sanctions (b), Danish Competent authority data





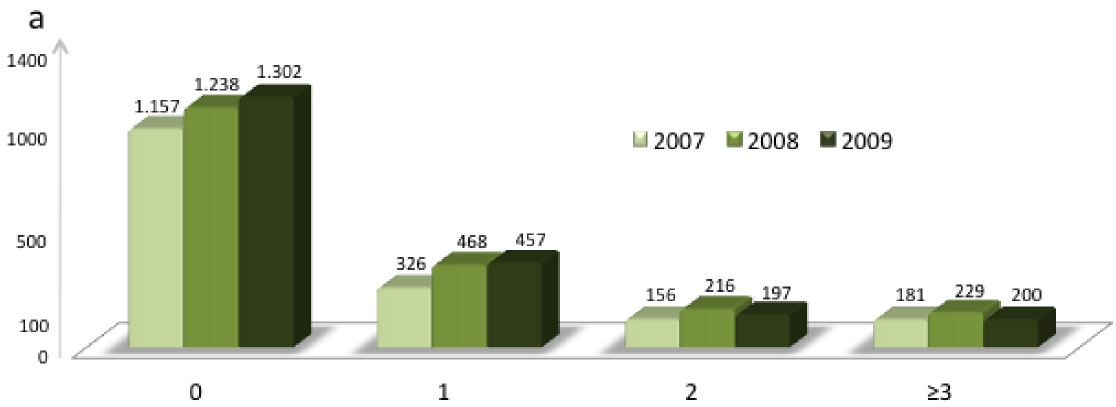
Source: Own calculations based on the CERTCOST data base.

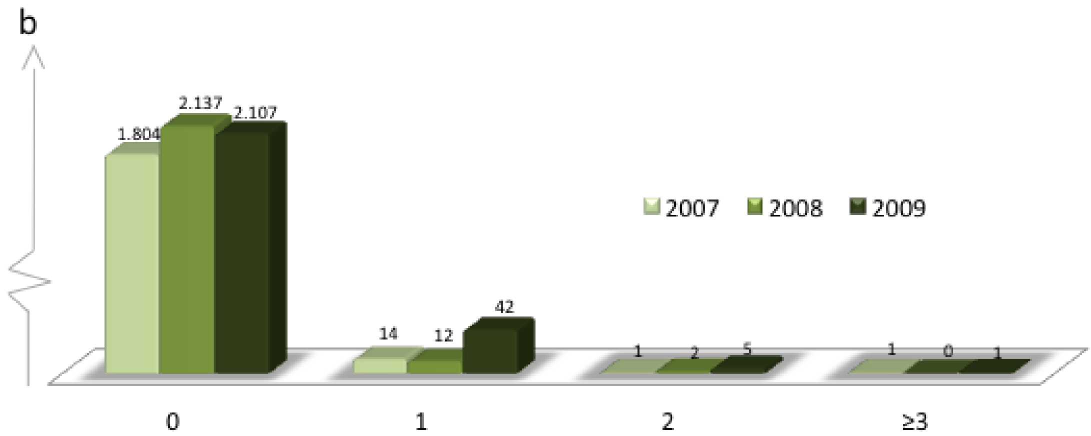
Figure 6: Number of farms by number of sanctions per farm and year; slight sanctions (a) and severe sanctions (b), Italian control body data



Source: Own calculations based on the CERTCOST data base.

Figure 7: Number of farms by number of sanctions per farm and year; slight (sum of minor and major) non-compliances (a), and severe (critical) non-compliances (b), British control body data





Source: Own calculations based on the CERTCOST data base.

3. METHODS

Modelling non-compliance in the European organic sector is a complex task. Data availability and quality strongly affect the information that can be used for the analysis. In addition to the data quality and coding issues already mentioned in the previous section, the available data on non-compliance suffer from a structural shortcoming: only information about detected non-compliances can be analysed, while nothing can be inferred concerning possible undetected non-compliances.

In the context of a risk-based inspection system, the evaluation of risk is directly dependent on the definition of risk that is assumed. In our context, two approaches to the definition of the risk of non-compliance can be considered: a narrower one that defines risk as the probability that non-compliance occurs, and a more general definition where risk is related to the overall potential damage arising from non-compliance (from an environmental and social point of view). In this report, if not otherwise indicated, we have used the term 'risk' as probability that non-compliance occurs, irrespective of the magnitude of the direct social damage potentially associated with it. A range of methods aiming at exploiting the available information from the dataset provided by Control Bodies was adopted: econometric and Bayesian Networks (BN) models aim to measure the quantitative impact on the probabilities of non-compliances due to structural and managerial operator characteristics, while a theoretical heuristic model considers the implications of non-compliance from a broader social cost perspective and provides simulations for the optimisation of the inspection systems.

Regarding the quantitative analysis, the choice of two methodological approaches allows investigating the determinants of risk factors from two different perspectives. Econometric models are based on a priori distributional assumptions, and provide a parametric evaluation of a (typically) linear relationship between sanctions or non-compliances and the potential risk factors considered. Results can be evaluated by specific statistical tests that measure the specific role of each risk factor. Bayesian Networks models on the other hand can be used as a 'data mining' tool, in order to identify the relationships among variables that emerge from the data, with no prior distributional or model specification assumptions, and measure the effect that single variables or group of variables may produce on the risk of non-compliance. The two approaches are complementary. The econometric approach provides results with statistical testing concerning the significance of each risk factor considered, given the distributional hypotheses considered; the Bayesian Networks approach allows a higher flexibility, particularly for the simulation of the joint effects of the combinations of various variables on the risk of non-compliance.

In what follows a more detailed description of the two methods is provided, together with a discussion concerning the theoretical specification of the heuristic model.

3.1. Econometric modelling

Discrete choice models were used to measure the effect of different variables on the probability of non-compliance and sanctions. According to country conditions, data availability and quality, different approaches were considered: binary choice models, count data models, and cross section or panel approach (see among others Greene, 2008; Cameron and Trivedi, 1998). Discrete choice models focus on the impact of explanatory variables, and provide an exhaustive set of diagnostic indicators to assess the statistical relevance of results. The aim is to identify relevant risk factors among the available variables, with a standardised statistical approach.

46 hypotheses concerning factors potentially affecting the probability for an operator to be non-compliant were generated in collaboration with all project partners. The hypotheses referred to the following aspects:

- general risk factors related to previous and concurrent non-compliances and other control related issues
- operator's structural/managerial characteristics
- specific crop, livestock and product variables.

Some of the hypotheses could not be tested for all countries and for all years due to missing data (e.g. processor turnover).

In this summarising report for each country (with the exception of Turkey, where data do not distinguish the type of non-compliance/sanction) two models have been considered, one for 'slight' non-compliances and one for the 'severe' ones. Different model specifications were analysed and tested. Count data models have been preferred to binary choice models as they exploit all the available information in terms of number of non-compliances. The only exception is the model for Turkey, where a simple Logit approach has been used. Distributional assumptions in the specification of count models have been tested using state-of-the-art testing procedures. When feasible and required a panel data estimation procedure was used, in order to exploit the full range of data (2007-2009) at once. In most cases, the panel specification allowed for more consistent and stable results for the three years period considered[4]. However, due to the limited time dimension (three years), we could not consider explicitly the impact of non-compliance occurrence in the past. Nevertheless, results from previous cross-section modelling did show the relevance of past non-compliance occurrence in explaining current risk in CH, IT and UK

3.2. Bayesian network modelling

By using Bayesian Networks (BNs), our goal was to define a decision support tool that could guide an actor in a complex system, under uncertainty. Differently from a rule-based system implementing logical reasoning, a probabilistic network allows to make different types of inference about a complex system even when there is no complete information (Russell and Norvig, 2011). Probabilistic networks are based on the expert system approach developed by Horvitz et al., (1988). An expert system can be defined as the joint use of a “knowledge base” and of an “inference engine” (Cowell et al., 2007). The knowledge base in our case is the dataset containing the basic information about sanctions and structural and general risk variables. The inference engine is a set of rules that process the data provided and possibly integrates additional expert information in order to reach a model capable to represent effects of variables (events) on each other.

Bayesian networks can be used to analyse how each single variable – when individually considered – can affect this risk of non-compliance, and the cumulative effect of a combination of two or more variables on the risk of non-compliance. Here we focus only on the first type of analysis, as the resulting outcomes are more directly comparable with those of the econometric modelling. Only variables producing at least a 10% variation on the probability of sanction or non-compliance detection are considered as having a relevant impact on risk. The analysis has been done on both 2008 and 2009 data, which allowed estimating the effect of non-compliances that occurred in the past (e.g., the effect of 2007 non-compliance on the risk of non-compliance occurrence, and 2007 – 2008 non-compliances on the risk of 2009 occurrence). Results from Bayesian Networks discussed in Chapter 4 will refer to a variable as a relevant risk factor if it shows a relevant effect on the risk of non-compliance either in the 2008 and/or in the 2009 model.

[4] The exception are the models for ‘slight’ sanctions for the control body in CH, and the ‘severe’ sanctions for the control body in IT; in these cases a panel approach is not necessary but has however been preferred as it does not affect the quality of estimations but allows for a more direct comparison with the other models, and stabilises the effects of risk factors over the three years period.

3.3. Heuristic modelling

A heuristic model is a rule-based model that helps to better understand reality. It is built upon theory and information sources that are only loosely connected and would not qualify as a direct representation of reality. In our case, the purpose of such a model is to understand the interplay of important factors that determine non-compliance, to derive consistent hypotheses for statistical analyses, and especially to make qualitative statements on optimum inspection strategies.

The general theoretical framework for modelling an opportunistic (or inadvertent) operator's decision to comply with an organic standard or not is based on the 'Economics of Crime' approach (Becker, 1974, 1976; Stigler, 1970; Pyle, 1983).

The objective is to implement inspection frequencies in a way that net social cost arising from farmers' non-compliance with organic standards will be at least approximately minimised. Net social cost here mainly consists of the social damages linked to non-compliance plus cost resulting from inspections.

For rough estimates of the model parameters the interplay of important factors, which need to be considered when planning inspection strategies, was analysed. Also, the potential effect of the hypothetical introduction of fines in the certification system is considered. Different scenarios we developed, combining different fines and compliance cost distributions. This analysis was done by means of Monte Carlo simulation[5].

[5] Monte Carlo simulation relies on repeated random sampling to determine the properties of some phenomenon (or behavior).

4. RESULTS

In this section we show the main results from the analysis. Our goal was to find out which structural and managerial factors are more likely to be associated with the occurrence of non-compliances. It is necessary to remind the reader that, in our dataset, the available information about the detection of non-compliant behaviour does not always indicate in detail the actual behaviour that led to the irregularity or infringement. This lack of information partly depends on the fact that we could only work – with the exception of UK – on sanction data (see Chapter 2). All we know is that the operator has or has not received a certain category of sanction, and we can relate this information only to structural and/or managerial characteristics of the operator himself. But even in the case of the UK, where we analyse non-compliance data directly, we have manageable data only on the severity of the non-compliance and not the causes. In general, we often do not know if the non-compliant behaviour refers to all farm operations or just to a single crop/livestock. As a consequence, our analysis is limited to unveiling some regular pattern possibly explaining an increase or decrease of risk.

The results shown in this section combine those from both the econometric and Bayesian modelling. Both approaches give a probabilistic evaluation of the risk of non-compliance for a list of risk factors.

Results should be interpreted as follows: if a certain risk factor – e.g. GMO-risk crops – shows a positive impact on the risk of non-compliance, it means that operators producing GMO-risk crops are more likely to be non-compliant than others. However, we cannot conclude that GMO-risk crops are actually a direct cause for non-compliances.

It should be noted that the main results presented in the following have to be seen as an illustration on how the statistical methods applied can be used for the identification of risk factors. By no means, the reported statistically significant variables should be misunderstood as key factors that will *always* increase or reduce risk of non-compliance. Depending on different site conditions and inspection procedures, the significant risk factors are likely to change with country, control body and time. However, Risk Based Inspections (RBI) may be based on applying statistical analyses as the ones presented below on control body data in order to inform inspection strategies. If the analysis is updated introducing new evidence each year, the efficiency of the inspection system could be enhanced. In any case, it must be clear that any statistical analysis can only predict the probability of occurrence of non-compliance based on past evidence.

We present an outline of the main findings of the econometric and Bayesian modelling of the risk for non-compliances/sanctions to occur. A common set of potential relevant influencing variables has been defined (Table 3).

Table 3: Variables taken into consideration for risk modelling

Risk factor category	Variables
General risk factors	Farmer with sanctions or non-compliance evidence (either sanctions or non-compliances in the past or in the same year); Farmer's experience as organic (this variable is a proxy: only farmer's experience with the corresponding control body could be measured).
Structural/managerial risk factors	Farmer is licensed to sell organic products[6] (only in IT and DK) Farm size (ha); Non organic land in the farm; Complexity of crop production; Number of other certification schemes; GMO risk crops (maize, soya); Livestock units (LU); Livestock density (LU/ha >2); Livestock Units > 30 LU; Livestock Units < 10 LU; Complexity of livestock production; Number of processing activities/product types processed; Farmer with a license for marketing organic products
Crop/Livestock specific factors	Crop type; Livestock type.

Source: Own variable list, based on the CERTCOST data set and the hypotheses derived.

Results of statistical analyses refer to farmers and farmers with processing activities. Two case studies for pure processors are added for IT and UK.

[6] In Italy and Denmark, farmers and processor who want to sell their products as organic, have to request a special "licence" to be issued by the control body. They are listed in a special public registry.

4.1. Results of farm-data models

A summary of the main findings of econometric and Bayesian Network models is shown in Tables 4, 5, and 6.

In these tables we report as risk factors those variables that emerged as relevant from *either one* of two types of models (econometric and/or Bayesian Network). In doing so, we expect to have increased the *sensibility* of our integrated risk modelling (i.e. its capability to identify possible risk factors) at the expense of its *specificity* (i.e. its accuracy in avoiding false positive risk reporting, since some factors were only found relevant in one set of models).

For the econometric analysis, we used a 95% significance level as a criterion for discriminating risk-increasing/decreasing factors from non-relevant variables.

For the Bayesian Networks analysis, we considered significant a 10% increase/decrease in the risk of non-compliance (Gambelli et al., 2012).

Results have been summarised across years with the aim of providing a general picture of possible common risk patterns across the EU countries for which results from both types of analysis are available. Results from the econometric modelling refer to the 2007-2009 panel models, while those from Bayesian Networks models consider the years 2008 and 2009 (variables that have been found as relevant risk factor for slight and/or severe non-compliance for at least one year are considered). The only exception is Turkey, where no livestock farms are surveyed, no data on processing activities are available and only data for two years (2008 and 2009) are available, and only a simpler form of econometric modelling was possible.

As a general result, only few general or structural variables provide a common risk pattern for all countries, while the impacts of specific crops and livestock vary across country and category of non-compliance. This was expected given the wide variety of agricultural conditions in the analysed countries.

The only common cross-country risk factor, for both the slight and severe non-compliances, is given by the **concomitant occurrence of other non-compliances** in the inspected farm: farmers that were found to commit irregularities (i.e. slight non-compliances) are more likely to be found to perpetrate infringements (i.e. severe non-compliances). This has emerged in both the econometric and Bayesian Network models. In addition to this, the latter models show that farmers' non-compliant behaviour follows a pattern of **'history (or path) dependence'**: operators who have been non-compliant in the past tend to continue to be so in the coming years.

This risk factor could not explicitly be considered in the panel models due to the limited time span of data available, but it was confirmed by exploratory cross sectional analysis for the CH, IT and UK cases. The importance of previous and concomitant non-compliances as a risk factor shows the relevance of *farmer-specific* factors in affecting the risk of non-compliant behaviour. In other words, information on non-compliances can be a proxy for other potentially important information about the farmer (such as age, education, time in business, liabilities and debts) that is not explicitly recorded or considered by control bodies.

Among structural risk factors, the only one emerging as generally relevant for explaining (slight) non-compliances in all countries is **farm size**: larger farms are more likely to be found non-compliant – at least with respect to irregularities – in all countries surveyed, and in 3 out of 6 countries with respect to infringements. In general, larger and more complex operations (in terms of number of products and crops) appear to be more at risk in all countries excluding Denmark. Larger numbers of animals also increase the risk of slight non-compliances in all countries except Germany.

Herd size and its complexity (number of animal species per farm) is indeed emerging as a specific risk factor for most countries, especially for slight non-compliances. Pigs and poultry productions – in particular – increase the risk of slight non-compliances in all countries considered, the former being related to severe non-compliances in all countries but UK. But other animal production is generally a risk factor in 4 out of 5 of the countries for which we have livestock data[7].

Among crop-related risks, none refers to all the countries investigated. Only green fodder appears to be related to slight non-compliances in 4 out of 6 countries and this could be directly related to livestock operations. Beside this, no common risk pattern can be found in relation to crops in all countries, most influences are very country specific.

Having reported the results for risk-increasing factors, a few words are needed with respects to those factors related to a **decrease** in the risk of non-compliance.

Among these, only fruits appear to have some impact in at least half of the surveyed countries (DK, IT, TR), but in general these factors are much more scattered and at maximum specific to one or two countries. It is worth mentioning two specific Mediterranean permanent crops – namely citrus and olive, occurring in IT and TR: the former is always related with decreased non-compliant behaviour in IT; the latter decreases the risk of severe non-compliances in both IT and TR, but appear related with increased risk of slight non-compliances in IT.

Among general risk factors, ‘Farmer’s experience’ (measured by a proxy, i.e. the number of years the farmer has been inspected by the control body) is decreasing the risk of all types of non-compliances in Germany, and of irregularities in UK.

[7] In TR there are no data on livestock.

Table 4: Factors increasing/decreasing the risk of non-compliance, per category of non-compliance (general and structural/managerial risk factors)

Variable	INCREASING the risk of		DECREASING the risk of	
	SLIGHT	SEVERE	SLIGHT	SEVERE
	NON-COMPLIANCE		NON-COMPLIANCE	
General risk factors				
Non-compliance occurrence in the same year (strong for weak non-compliances model; weak for strong non-compliances model)[1]	✓[4]	✓		
Non-compliance occurrence in the past (BN models only)[1]	✓	✓		
Farmer's experience[1]			DE, UK	DE
Structural/managerial farm specific risk factors				
Farmer is licensed to sell organic products[2]	DK	IT		
Number of other certification schemes[1]	IT, CH			CH
Farm size (ha)	✓	DE, DK, IT		
Non organic land[3]	DE, UK	DE, IT, TR	IT	
Number of products/Processing activities[1]	CH, DE, IT, UK	CH, IT		

[1] Not available in TR data
[2] Not available in CH, DE, TR, UK data
[3] Not available in DK data
[4] ✓= Variable has been found to be influential in all countries investigated

Source: Own calculations based on the CERTCOST data base.

Table 5: Factors increasing/decreasing the risk of non-compliance, per category of non-compliance (specific crop risk factors)

Variable	INCREASING the risk of		DECREASING the risk of	
	SLIGHT	SEVERE	SLIGHT	SEVERE
	NON-COMPLIANCE		NON-COMPLIANCE	
Specific crop risk factors				
GMO-risk crops	UK	DE, IT		
Complexity of crops production	CH, DE, IT, DK	DE, IT, TR		
Cereals	CH, IT	IT		TR
Industrial crops	CH, DE	DK, IT, TR		
Dried pulses	IT	DE, IT		
Root crops	DE, UK	DE, IT, UK		
Grassland	IT	IT	DE	CH
Green fodder	DE, DK, IT, UK	CH, DE, IT		
Unutilised land	CH, DE, DK	IT		
Other arable crops	DE	DE, IT		
Vegetables	DK, UK	CH, IT		
Fruits (incl. nuts)	CH, DE		DK, IT	DK, IT, TR
Olives[1]	IT			IT, TR
Grapes	CH, IT	CH, DE, IT		
Citrus[1]			IT	IT

[1] Only for IT data

Source: Own calculations based on the CERTCOST data base.

Table 6: Factors increasing/decreasing the risk of non-compliance, per category of non-compliance (specific livestock risk factors)

Variable	INCREASING the risk of		DECREASING the risk of	
	SLIGHT	SEVERE	SLIGHT	SEVERE
	NON-COMPLIANCE		NON-COMPLIANCE	
Specific livestock risk factors[1]				
Bovine	DE, DK, IT, UK	CH, DE, IT		
Goats	CH, DE, DK, IT	CH, DE		
Pigs	✓[2]	CH, DE, DK, IT		
Poultry	✓	DE, DK, IT		
Sheep	CH, DE, IT, UK	DE		
Livestock units (LU) (BN models only)	CH, DK, IT, UK	CH, IT		
Complexity of livestock production	✓	CH, DE, DK, UK		
Livestock density (BN models only) (LU/ha > 2)	DK, UK	DK		

[1] Not available in TR data.
[2] ✓= Variable has been found to be influential in all countries investigated
Source: Own calculations based on the CERTCOST data base.

The overview of results presented above is based on a comparative analysis using a negative binomial panel model (unpublished) and Bayesian Network models (Gambelli et al., 2012). Various alternative approaches exist next to the econometric count model, particularly different categorical models such as the binary logistic regression model or the ordinal regression model. However, the negative binomial panel analysis was commonly applied as econometric approach in all countries to obtain results from one selected methodology. Beyond the analysis presented above, we performed in-depth, country-specific case studies (Lippert et al., 2011; Solfanelli et al., 2012; Zorn et al., 2012b). In these studies we could chose the appropriate econometric estimation techniques according to specific data characteristics of the respective country (see also Chapter 3.1). This resulted in methodologies applied that differ from the methodology chosen for cross-country analysis (amongst others, e.g., cross-sectional ordinal logistic regression, logistic panel regression). The results from these in-depth case studies were in many cases analogous to the results reported here, so in those cases the different methods confirm each other.

The partly different results in our in depth case studies can be explained, first, by the method applied. In each case study, we performed different econometric model approaches before selecting the model most appropriate to the specific data characteristics. When selecting the model approach we intended to use as much from the available information as possible. Second, the way the models were built is another source for potential differences. For some variables we discussed different alternatives on how to model the hypothesised effect: e.g., the variable “number of other certification schemes” partly was considered only as dummy variable (indicating only the presence of other certification schemes, but neglecting its number).

4.2. Results from processor-data models: case study in IT and UK

In this section we report the findings of the case study on the risk of non-compliant behaviour of pure processors, i.e. processors without farming activities of control bodies in Italy and the United Kingdom. Table 4 summarises the distribution of sanctions for the period from 2007 to 2009 for the IT control body and Table 5 the distribution of non-compliances for the UK control body. The variables taken into consideration are:

- *General risk factors*: slight and severe sanctions for IT; slight and severe non-compliances for UK; number of other certification schemes
- *Structural/managerial processor-specific risk factors*: processor has a license to market organic products (only for IT), experience as organic processor (i.e. number of years under control body’s inspection), number of processed products
- *Product-specific risk factors*: processing of cereals and flours, pasta and bakery products, pulses, milk and dairy products, meat, eggs, fruits and vegetables, oils, seeds and industrial crops, other products

Unfortunately, no information concerning structural aspects like turnover, number of employees, number of brands was available for all operators, so the relative importance in terms of turnover of the various processed products could not be considered.

4.2.1. Analysis of risk factors of non-compliances for processors for the Italian case study

The share of pure processors with at least one sanction is quite low even for the ‘slight’ category, and stays broadly stable in the three year’ period considered. With respect to the severe sanctions, in 2008 and 2009 only very few cases with just one sanction are recorded.

An econometric (negative binomial) model has been used to analyse the statistical relevance of potential risk factors for the slight non-compliances. Results for IT show that the risk of slight sanctions increases if the processors also got severe sanctions, and vice versa. Of the specific products, pasta and bakery and other minor products were found increasing the slight sanctions risk. The numbers of severe sanctions are so small that a simpler (logit) model was used, showing only the presence of slight sanctions as a risk factor.

Table 7: Distribution of processors by sanction category and year, IT data

	Number of sanctions					
	Slight			Severe		
Number of sanctions per processor	2007	2008	2009	2007	2008	2009
0	1,558	1,676	1,866	1,594	1,725	1,908
1	50	57	51	20	11	14
2	10	3	5	3	0	0
3	0	0	0	1	0	0
Number of Processors (total)	1,618	1,736	1,922	1,618	1,736	1,922
Share of proc. with at least 1 sanction (%)	3.71	3.46	2.91	1.48	0.63	0.73

Source: Own calculations based on the CERTCOST data base.

4.2.2. Analysis of risk factors of non-compliances for processors for the British case study

Given the extreme sparseness of data on severe non-compliances in the pure processor data of the British Control body, a negative binomial model referring only to slight non-compliances has been used to analyse the statistical relevance of the potential risk factors. Results for the British case study show co-dependence, i.e. the risk of minor non-compliances increases if the processor commits severe non-compliances. Besides, the risk increases if the processor has a long experience as an organic operator, and if other certification[8] is requested. Of the specific products, pasta and bakery and meat were found increasing the minor non-compliance risk.

Table 8: Distribution of processors by non-compliance category and year, UK data

Number of non-compliances per processor	Number of non-compliances					
	Slight			Severe		
	2007	2008	2009	2007	2008	2009
0	2,224	2,531	2,357	1,482	1,817	1,605
1	334	491	456	11	11	11
2	177	304	193	3	4	1
3	117	144	95	0	1	1
4	53	79	60	0	0	0
5	36	50	44	0	0	0
>=6;	51	67	31	0	0	0
Number of Processors (total)	1,496	1,833	1,618	1,496	1,833	1,618
Share of proc. with at least 1 non-compliance (%)	51.34	61.92	54.33	0.94	0.87	0.80

Source: Own calculations based on the CERTCOST data base.

4.3. Results from the heuristic modelling

To derive statements on optimum inspection strategies one has to be aware that important parameters like farmers' average compliance cost or average damages resulting from non-compliance with standards will never be exactly known. This means for these variables reasonable assumptions have to be made. Only under such assumptions it is possible to produce quantitative simulations.

Simulations showed that even without fines (which is the current situation within the organic sector in Europe) a situation can be imagined where a large proportion of organic farmers comply. Introducing fines could facilitate standard enforcement and reduce corresponding societal cost. Another general result was that organic farms should be separated into relatively homogenous groups in terms of risk factors, when designing inspection strategies since then the effects of different control strategies on farmers' compliance behaviour are easier to assess.

The complete mathematical derivation of the comprehensive heuristic model and the Monte Carlo simulations are not presented in this report, because this would have made the report quite difficult to read. These details have been documented in Lippert et al. (2012).

[8] Other certification is related to other organic standards additional to the EU ones, like NOP, JAS, Bio-Suisse, etc..

5. CONCLUSIONS[9]

5.1. Summary of the key findings

Summing up our analysis, on both farmer and processor data the distribution of non-compliance shows that the share of non-compliances is quite low for all the countries considered, with a generally higher occurrence of slight non-compliances compared to the severe ones.

The only general conclusion that can be drawn **for all countries**, **all modelling approaches** applied for this report and for **both farmer and processor** data is the fact that occurrence of non-compliance is critically affecting the risk of further non-compliant behaviour.

This result, which in simple words can be rephrased as “operators who are not compliant tend to continue to be so“, may occur in two coexisting variants:

[9] In the results Sections 4.1, 4.2 and 4.3 we have reported the results of the calculations and we have clearly distinguished where calculations were performed with sanctions and where calculations were performed with non-compliances. As we see sanctions as a proxy variable for non-compliance and as non-compliance is the variable we really want to explain, we summarize and interpret the results in this chapter by leaving the distinction apart. We thus interpret all results as explaining non-compliance in this section.

- *co-dependence*: if one operator has committed irregularities (i.e. slight non-compliances) he or she is more likely to have also been found committing severe infringements
- *path-dependence*: if one operator has been non compliant in one given year he or she is more likely to be also found non compliant in the coming years.

A widespread importance as a determinant of non-compliance across countries for slight non-compliances seems to be associated with:

- farm size and complexity of operations;
- livestock operations in general and pigs and poultry in particular.

Another important consequence of our findings is that – ***based on currently available data*** – a risk-based inspection strategy is quite difficult to implement. Inspection data contain mainly data on structural aspects and to a varying degree data on quality/quantity of management, but little or no personal information about the operators. Indeed, the data collected by control bodies are particularly detailed with respect to structural aspects. For example, there are very detailed crop classifications but very little information on the farms/processors (e.g. age of farmer or processor when family enterprise, total turnover, liabilities and debt, solvency, etc.).

Besides this, using models based on past evidence – as the one we have used – can help in limiting *what we already know* about risk, but cannot avoid unpredictable (and potentially disruptive) events based on 'new', yet undiscovered factors.

An efficient Risk-Based Inspection system, should weight the known **probability of occurrence** of a given non-compliance with the **severity** of its impact (and, possibly, for the **probability of detecting** the given non-compliance, which is very difficult to assess), a procedure we have used in the heuristic model.

5.2. Actions and recommendations

As a result of our analysis, two main issues have emerged as crucial when dealing with the analysis of risk of non-compliance in the organic certification system at a European level:

- The need for a homogeneous and clear definition of non-compliances and sanctions according to severity for use in the certification and inspection system across the EU.
- The need for an EU wide common framework for a risk-based inspection system for the organic certification.

The two aspects are closely related, as the implementation and performance of a risk-based inspection system severely relies on standardised codification of non-compliances and sanctions.

The experience gained so far in the CERTCOST project has also identified some practical actions that could help establishing improved risk-based inspection protocols in the organic certification system.

Standardisation of coding for non-compliances and sanctions

Although the main scope of the organic inspection and certification system is to verify compliance and to detect and sanction the occurrence of non-compliances with the organic regulations, a clear definition and classification of non-compliances is still missing. In both organic regulations (Reg. (EC) 2092/91 and (EC) 834/2007), no explicit definition of the terms irregularity and infringement is provided. However, we can infer that irregularities are less severe violations than infringements, but this is not of great help. A clear interpretation of non-compliances is essential to reach a common framework for organic inspection systems across Europe. A codified approach to non-compliances classification in terms of type and severity is necessary to clearly associate sanctions and non-compliances. Such a common framework is a pre-condition for the development of a risk-based inspection system.

The present situation is extremely diversified across countries. In the CERTCOST project we have collected data on non-compliances and/or sanctions from five control bodies in CZ, IT, DE, UK, CH,TK and a control authority in DK. These CBs do not use common definitions for sanctions and non-compliances. For example the German and Czech control bodies are obliged to report non-compliances to the supervising authorities according to which article of Reg. (EC) 834/2007 (previously EEC/2092/91) is violated, and the German data provider stores detailed textual descriptions of each non-compliance. The Swiss control body has an internal coding system and a textual description of non-compliances; The Italian control body and the Danish control authority refer to agreed national standards for classifying non-compliances and issuing sanctions, while the British control body uses a 4-point ordinal scale for classifying the severity of non-compliances and keeps textual descriptions. In most cases, these textual descriptions of non-compliances are the only direct source of information to understand the severity of the violation, but ambiguous descriptions can make standardised interpretation quite difficult. A similar picture exists for the sanction level (see Table 1).

A clearly defined classification of non-compliances could help in achieving the following objectives. On the one hand, it would allow the comparison of non-compliances and their severity across control bodies and countries, making the inspection system more transparent and allowing meaningful supervision reports (Zorn et al., 2012a). On the other hand, it could make the association of non-compliances with related sanctions more precise, assuring a standard for standardising the sanctions. Common definitions of non-compliances and a uniform sanction code would harmonise the organic inspection system across EU. This would cover the gap between a common regulation for organic farming, and the proliferation of non-comparable procedures for the implementation of this regulation.

National accreditation bodies could play an important role in this respect. Accreditation is presently operating under the EN 45011/ISO Guide 65[10], and an operative harmonisation of national accreditation bodies could be a substantial step

[10] EN 45011 / ISO/IEC Guide 65 (ISO/CEN, 1996); general requirements for bodies operating products-certification systems,

towards the development of a harmonised classification standard of non-compliances and sanctions across EU.

A risk-based inspection approach to organic certification

A risk-based inspection scheme is a planning tool used to develop the optimum plan for the execution of inspection activities. Organic certification systems could benefit from a better and more efficient implementation of risk-based inspections systems in terms of higher effectiveness, and lower transaction costs for organic operators, and this is envisaged in the Regulation (EC) 834/2007. The goal of a risk-based inspections system is to develop a cost-effective inspection programme that provides assurance of acceptable integrity and reliability. Risk-based inspections systems use the findings from a formal risk analysis – according to defined criteria for inspection planning and the physical inspection procedures. Planning risk-based inspection protocols in the organic certification system should be based on two prerequisites: the improvement of data recorded in order to better analyse the probability of non-compliance, and a rational economic evaluation of the benefits of introducing higher efficiency and effectiveness in the certification system.

Regarding the data issue, we have already mentioned that control bodies – in most surveyed countries – currently record many data about the farms, but little about the farmers themselves. This is even more pronounced when processor data are analysed, since essential information like turnover or capital stock is not recorded in most cases, and there is a total lack of data concerning the characteristics of the owners or managers of the processing company. No bank would authorise a loan based only on physical characteristics of a firm, not even its assets, unless some personal information is gathered on the trustworthiness of the borrower. More information needs to be collected on these aspects, since we have shown that most of the explanatory power of our models resides in behavioural factors represented by concurrent or past occurrences of non-compliance. If possible, bank information, the debt history of the operator and her solvency, her criminal record, etc. needs to be collected and recorded as standard by all control bodies. Of course these suggestions for potentially useful data have to be weighed against data protection considerations.

Regarding the second issue, a clear definition of “risk” is essential for a correct implementation of a risk-based inspection system. In the context of organic certification, risk can be defined and understood in two ways: risk defined as probability of the occurrence of non-compliance (hence a “micro” approach aiming mainly at the improvement of the inspection systems), and risk in terms of potential negative effects at a societal level due to an ineffective certification system (hence a “macro” approach considering the potential implications for the organic business, environment and society from a general optimisation perspective) (for the definition of ‘risk’ see also the glossary in Zorn et al. (2009)). In this study both types of risk concepts have been taken into consideration, developing statistical models aimed at the identification and measurement of the potential risk factors of non-compliances, and developing theoretical models aiming at the optimisation of the certification system.

For what concerns the first approach to risk evaluation, the implementation of a codified risk-based inspections system approach becomes particularly relevant if it can be harmonised at the level of general elements of certification system, and then applied to the systems of different countries. A common framework for inspections at EU level allows a consistent monitoring of the organic certification process, and creates the basis for the use of statistical tools for the identification of the critical risk factors to be considered in the organic system, hence providing a scientific support to the focussing of control activities towards more risky cases. Clear and uniform criteria for classifying non-compliances as well as better data and information systems are required to successfully implement risk-based inspections systems on a larger scale.

The heuristic model developed in this project should be adapted to different organic farming situations characterised, among other things, by specific compliance costs, possible damages and hazards. If this is well done – at best with the help of local experts and stakeholders – the resulting models can be used to improve the efficiency of organic farming inspection systems.

A weighted rating approach such as FMEA (Stamatis, 2003) may put all these suggestions into practice and increase the effectiveness and the efficiency of inspection procedures.

5.3. Limitations of this study

In this section we discuss some major issues concerning limitations of the data, methods, and assumptions used. First of all, our empirical findings on the risk of non-compliances suffer of a representativeness bias. The data analysed cover, in most of the countries considered, only a share of organic operators, and for a limited time span. Results here discussed should be considered as a first insight into the (yet) little investigated effectiveness of inspections and controls in the organic sector, without attempting to generalise the results.

In addition, we can further distinguish between two main areas of data issues. The first one is somehow “structural” and intrinsic to our dataset, compiled using standard data collected and recorded by control bodies concerning the detected non-compliances and related sanctions. Necessarily, only information on non-compliances actually detected can be analysed, but we have no idea about the number and kind of non-compliances that could not be found during the inspections. This addresses the fundamental statistical problem of non-detection (or “underreporting”), which appears because not all non-compliances are detected and recorded in the data (Allingham and Sandmo, 1972; Feinstein, 1991; Sandmo, 2002). The reasons for potentially undetected non-compliances can be: the timing of the visit (e.g., a farmer could commit a non-compliance after the annual control visit), the effectiveness of the inspection visit, the percentage of (product/soil) samples taken, the number of unannounced visits, etc. However, the key information we were dealing with – number and types of non-compliance– is almost certainly affected by “missing” data, which implies the so called “underreporting” problem (Winkelmann and Zimmermann, 1995; Winkelmann, 1996) linked to the probability that each non-compliance is detected and recorded.

Apart from this critical shortcoming, which must be considered as intrinsic in this type of analysis, we should also consider more specific data issues that could be solved to improve risk-based inspection systems. The statistical approaches used here cover a wide range of methods, with different scopes, data requirements and assumptions, and all together are exploiting all the available information we collected from control bodies. However, the different data availability across countries and the different information recorded and varying definitions concerning non-compliances make EU-wide assessments a difficult task. Data from control bodies have shown to be useful, but are probably not sufficient for in-depth Risk Based Modelling. In particular, presently the data from control bodies contain information about operators' structural data (e.g. size, type of product/crop/livestock) but little or even no information on farmers/managers individual characteristics (e.g. age, education, time in business, criminal record, etc.), and economic/financial information (e.g. turnover, overall level of debt, etc.). Risk analysis would be improved greatly if such data were available. Of course, some of this data are highly sensitive and are affected by data protection issues.

All operators have to be inspected at least once per year, as a legal requirement. But the number of subsequent inspections (either unannounced or follow-ups) varies across countries and control bodies. This could well be related to each case, e.g. possible damages and/or non-compliance behaviour varies among different regions. However, in order to find out adequate inspection strategies an analysis similar to the heuristic modelling (Section 4.4) needs to be done. Notwithstanding the general equity issue of equal control standards across EU, it is very unlikely that a uniform inspection strategy (including fixed obligatory inspection frequencies) for all types of organic farms all over Europe makes sense.

Finally, some general epistemological and methodological issues should be discussed. A first point concerns the implications of the approaches used by control bodies for the choice of timing and operators to inspect. We are in fact processing information from data collected by control bodies, but the way the data generating process is structured can severely affect the results of the analysis. Since control bodies are actually using some form of internal risk-based inspection system protocol to inform timing of compulsory announced inspections as well as follow-up and unannounced inspections, the risk factors that we have observed may simply depend on their inspection planning and not necessarily on the actual risk. In other words the analysis based on this type of data may suffer from a "confirmation-bias".

Further issues to discuss are mainly methodological. In the econometric and Bayesian modelling in particular, the reliability of the analysis of factors influencing severe risks is limited for statistical reasons due to the low number of severe non-compliances and related sanctions in the basic data. This is a structural shortcoming, even if some of the methods we have used for data analysis can be considered sufficiently robust. However further efforts can be made to better adapt the methods of estimation by using approaches (e.g., zero-inflated count models) that could minimise the effects of overdispersion of negative cases in our sample, as has been done with the Italian data (Solfanelli et al., 2012).

With respect to heuristic models the results of optimising inspection and sanction strategies severely depend on the assumptions made by the decision makers of the competent authorities or control bodies. In order to avoid flawed results these assumptions as well as the resulting optimised strategies should be continuously discussed with stakeholders within the organic sector. Also careful sensitivity analyses, e.g. with respect to different assumptions on potential societal damages of non-compliances, should be done.

Besides the inspection scheme for organic farms (which was in the focus of the CERTCOST project) also the supervision of the entire organic supply chain should be analysed. In this context the well-functioning implementation of full traceability may increase the detection probability and consequently reduce the number of non-complying farms and resulting damages at relatively low cost. The dynamics of the inspection system is a further aspect that could be included into a heuristic model as farmers' expectations are based on previous experience, they will adapt their compliance behaviour according to perceived *past* inspection and sanction frequencies. Finally, when analysing the effects of fines also transaction costs for law suits etc. have to be considered as well as additional social cost due to risk-averse farmers who do not convert to organic farming because they fear (unjustified) sanctions.

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