Review of socioeconomic tools and models for preventing, detecting, and mitigating food fraud

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Summary

The present report aimed at reviewing both the theoretical as well as the empirical literature on food fraud, which is usually defined as deception for economic gain using food. More specifically, the overall goal was to provide a review of existing analyses addressing food fraud from a social sciences perspective. For this purpose, relevant literature was searched, reviewed and analysed in order to provide a solid knowledgebase for further discussions among regulatory bodies, policymakers, private businesses and scientists, regarding how to address fraudulent activities in food supply chains, especially regarding setting up appropriate prevention measures.

Based on the review several central points emerged.

First, no harmonised definition of food fraud exists and food fraud can appear in many different forms such as adulteration, counterfeiting or mislabelling. Thus, food fraud is a multifaceted problem and can have very different impacts on consumers ranging from direct health treats such as the consumption of toxic contaminants to technical threats such as the mislabelling of the country of origin.

Second, given the lack of statistics about food fraud incidents - due to its very nature - statements about its extent and severity are based on detected cases and educated guesses. According to existing knowledge, food fraud in the EU seems to be especially pronounced for products such as olive oil, spices, honey, and fish/seaweed. However, at the same time it needs to be kept in mind that the higher share of products found to be adulterated in these categories might also be a direct result of a higher control intensity for these food groups due to previous food fraud cases.

Third, even though organised criminal groups (food mafia) seem to play a certain role in fraudulent activities in the food sector, in most cases it might be more reasonable to assume that ordinary businesses are involved in fraudulent activities. Thus, the routine activity and situational prevention theory, both applied in the field of criminology, as well as the economics of crime approach seem to be highly relevant concepts for the analysis of food fraud.

Fourth, vulnerability assessments should be considered as integral parts of food fraud management systems. Food fraud vulnerability is thereby determined by three key elements: opportunities, motivations and control measures. The overall goal of such assessments is to identify potential vulnerabilities in order to be able to set up countermeasures to minimise the incentives for individuals and businesses to engage in fraudulent activities.

Fifth, based on the existing knowledge from known food fraud incidents and vulnerability assessments, both macro- and micro-level factors must be considered simultaneously to assess fraud vulnerability and to set up and implement effective prevention strategies. Especially important factors to consider seem to be the ease and detection of adulteration of a certain raw
material, the presence of added value claims (e.g., organic, Protected Designation of Origin), and the complexity of the value chain (e.g., low transparency and traceability increases vulnerability).

Sixth, there is evidence that existing legal enforcement powers are not always used to their full extent, and control officials’ orders would be more effective if the sanctions for disobeying were rapid and sufficiently severe. In this context, it has been argued that fines are only one element of a food fraud fighting strategy which should also include other elements such as the withdrawal of licenses and authorisations, ‘naming and shaming’ techniques, and human capacity building measures.
1 Introduction

Food fraud is not a new phenomenon but, in fact, has a long history as references to the adulteration of food found in texts dating back to the days of the Roman Empire indicate (CAFIA, 2015; Lotta & Bogue, 2015; Shears, 2010). However, it has recently gained increasing attention as reflected in the number of scientific publications on the topic (Huck et al., 2016), as well as in the setting up of several initiatives to tackle food fraud, such as the EU Food Fraud Network (FFN) (Montanari et al., 2016). The FFN was established in 2014 as a reaction to the so-called horsemeat scandal\(^1\). In the aftermath of this scandal, the European Commission (2013) published a report, in which it was explicitly stated that even though no statistics exist on the incidence of food fraud, the EU Commission has identified food fraud as a new area of action. Besides these actions undertaken in Europe, other countries such as the United States and China have also set up different initiatives to address the topic of food fraud specifically (Spink et al., 2016a). Thus, food fraud has gained increasing attention as an important food risk and seems to rank high on the agenda of regulators and food industry stakeholders alike (Bouzembrak & Marvin, 2016; Ellis et al., 2015).

It is often argued that the increasing globalisation of food supply chains (FSCs) has contributed to an increase in food fraud activities, since the detection of fraud has become harder where FSCs are complex and food commodities change hands a number of times (e.g. Manning, 2016; NSF, 2014). At the same time, increasingly globalised FSCs imply that the impact of food fraud incidents can have internationally far-reaching consequences (Spink et al., 2017). Moreover, concerns have been expressed that food fraud risks may be more severe than traditional food safety risks, since adulterants used in fraudulent activities are often unconventional and current food protection systems are not designed to look for the nearly infinite number of potential adulterants (Spink & Moyer, 2011). This point might be illustrated with the widespread adulteration of milk products with melamine in China in 2008 with lethal consequences\(^2\). Since melamine is neither a permitted additive nor a food ingredient, established food systems did not detect this substance until health problems were reported and linked to the baby formula milk. Thus, only since the melamine contamination reported in China in 2008, the adulteration of protein-based food products with melamine has become a well-known issue. This case illustrates two important points in the context of food fraud: First, given the large number of potential adulterants in food the increasing development and application of untargeted analytical

\(^1\) The horsemeat scandal refers to the presence of horsemeat in pre-prepared food, mainly lasagne and burgers, without any declaration of horse meat on the package, food label or ingredients list in several EU countries in 2012/2013 (Agnoli et al., 2016).

\(^2\) Melamine is a synthetic chemical that was added to raw milk to increase the apparent protein content. In September 2008, Sanlu brand milk powder was found to cause an outbreak of kidney disease, due to the baby formula being contaminated by melamine. Six babies died and 294 000 were hospitalized by consuming the tainted formula (Wu et al., 2017).
laboratory approaches (i.e. methods that detect abnormalities without \textit{a priori} knowledge about potential adulterants) offers a promising technical solution to detect food fraud (e.g. Esslinger et al., 2014). Second, even though such technical solutions are definitely important and promising tools with regard to the detection of food fraud, given budget and time constraints they need to be coupled to a risk-based control plan in order to decrease the likelihood of food fraud at reasonable costs. Especially, identifying existing vulnerabilities inherent in FSCs seems to be one important part for setting up successful and cost-effective food fraud prevention strategies (e.g. Cavin et al., 2016).

Given this background, the present report aims at contributing to the discussion about food fraud prevention by providing a review of the current knowledge on the topic. The report focuses thereby particularly on the evolving literature analysing food fraud from a social science perspective. So far, there is a small and fragmented, but growing literature on food fraud located across academic journals associated with food science and criminology (Smith et al., 2017). Yet, other disciplines such as economics are also highly relevant for the analysis and prevention of fraud in general and food fraud in particular. Consequently, this report aims at providing a multidisciplinary review of the state of the art in approaches to prevent, detect and mitigate food fraud drawing on literature from the fields of (agricultural) economics, business management, economic sociology and criminology.

The report is structured as follows. The next section provides an overview of important definitions and terminology used in the context of food fraud. Thereafter, main legislations, regulations as well as non-governmental initiatives regarding food fraud are briefly outlined. Section 4 introduces important theoretical frameworks relevant for the analysis of food fraud. In section 5, existing databases providing empirical evidence on the extent and scope of food fraud are presented, followed by so far existing \textit{food fraud prevention-models}. Section 6 discusses the major outcomes of this report and concludes with providing recommendations for possible future steps.
2 Definitions and terminology

Given a range of different terminologies surrounding the topic of food fraud, this section will provide an overview of major keywords and the underlying definitions and concepts in order to ensure a common understanding.

As pointed out by Lord et al. (2017b) at its most basic level, the concept of fraud is ‘a way of making money illegally via deception’ that involves a process of some form of dishonest or deceptive practice and an outcome that is some form of advantage as a ‘goal’.

Furthermore, these authors conceptualise food fraud as “relating to the abuse or misuse of an otherwise legitimate business transaction and an otherwise legitimate social/economic relationship in the food system in which one or more actors undertake acts or omissions of deception or dishonesty to avoid legally prescribed procedures (process) with the intent to gain personal or organisational advantage or cause loss/harm (outcome)”.

At EU level, usually four different criteria are applied to define food fraud: (1) violation of food law, (2) committed intentionally, (3) in pursue an economic or financial gain and (4) by deceiving consumers³.

Most of the available scientific studies so far adopted the definition proposed by Spink and Moyer (2011) defining food fraud as the deliberate substitution, addition, tampering, or misrepresentation of food, food ingredients, or food packaging, or false or misleading statements made about a product for economic gain.

Besides, the term food crime is sometimes used in the scientific literature and public media. Croall (2007) introduced the concept of food crime, defining it as the ‘many crimes that are involved in the production, distribution and selling of basic foodstuffs’. However, in the more recent literature about food fraud a narrower definition of food crime has been introduced. According to Elliott (2014), food crime is used to refer to food fraudulent activities carried out by organised criminal groups. In this line, the National Food Crime Unit (2016) pointed out that the distinction between food fraud and food crime is generally one of scale and complexity, with the former sometimes an early indicator of the latter. Hence, the term food crime refers to fraudulent schemes conducted by organised networks as opposed to fraudulent activities carried out by individual business operators (Montanari et al., 2016). However, since it might not always be feasible or meaningful to distinguish between these two, the umbrella term food related criminality or simply food criminality has been introduced by several institutions/scholars (Fassam & Dani, 2017; National Food Crime Unit, 2016).

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³ Currently no harmonised definition of food fraud exists at EU level (https://ec.europa.eu/food/safety/food-fraud_en)
For the sake of clarity, this report will only use the term food fraud or fraudulent activities to refer to all kinds of food-related criminal activities disregarding of their scale and scope.

Several scholars provide further a more detailed categorization of food fraud activities. Spink et al. (2016b), for example, proposed to distinguish seven categories of food fraud, namely (i) adulteration, (ii) tamper, (iii) over-run, (iv) theft, (v) diversion, (vi) simulation, and (vii) counterfeiting. A more detailed description for each of these seven categories is provided in table 1.

The sub-category of adulteration is often referred to as **economically motivated adulteration (EMA) of food** and/or food ingredients and has received most attention in the literature so far (e.g. Everstine et al., 2013; Moore et al., 2012b; Spink & Moyer, 2011). Lotta and Bogue (2015) added to this discussion that food fraud types might be classified according to three main categories, namely food adulteration, misrepresentation and food related crimes, which usually entail the violation of non-food laws such as for example tax law or intellectual property rights.

### Table 1: Categories of food fraud

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adulteration</td>
<td>A component of the finished product is fraudulent</td>
<td>Melamine added to milk</td>
</tr>
<tr>
<td>(adulterant-substance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tampering</td>
<td>Legitimate product and packaging are used in a fraudulent way (Includes mislabeling)</td>
<td>Changed expiry information, product up-labeling, religious designation, etc.</td>
</tr>
<tr>
<td>Over-run and unauthorised production</td>
<td>Legitimate product is made in excess of production agreements</td>
<td>Under-reporting of production</td>
</tr>
<tr>
<td>Theft</td>
<td>Legitimate product is stolen and passed off as legitimately procured</td>
<td>Stolen products are co-mingled with legitimate products.</td>
</tr>
<tr>
<td>Diversion or grey market</td>
<td>The sale or distribution of legitimate products outside of intended markets (Includes smuggling)</td>
<td>Relief food redirected to markets where aid is not required</td>
</tr>
<tr>
<td>Simulation</td>
<td>Illegitimate product is designed to look like but not exactly copy the legitimate product</td>
<td>“Knock-offs” of popular foods not produced with same food safety assurances</td>
</tr>
<tr>
<td>Counterfeiting</td>
<td>Intellectual Property Rights (IPR) infringement, that could include all aspects of the fraudulent product and packaging being fully replicated</td>
<td>Copies of popular foods not produced with the same food safety assurances</td>
</tr>
</tbody>
</table>

Source: Spink et al. (2016b)

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4 Instead of adulteration, sometimes the term *intended contamination* is used in contrast to *unintended contamination* (Davidson et al., 2017).
Another proposed way to differentiate among food fraud activities is to take into account the impact of food fraud activities onto consumers. The Food Standards Agency in the United Kingdom for example differentiates between two types of food fraud. The first type comprises \textbf{food that is unfit and potentially harmful} and the second one refers to the \textbf{deliberate mis-categorisation of food}. While the first category poses health risks to consumers, the latter category is not necessarily unsafe but deceives the consumer as to the real nature of the product. A similar categorisation was proposed by Spink and Moyer (2011), who distinguish between three different types of \textbf{food fraud risks to public health}:

(i) \textbf{Direct food fraud risks}, i.e. immediate health consequences for example through acutely toxic contaminants;
(ii) \textbf{Indirect food fraud risks}, i.e. health consequences through long-term exposure;
(iii) \textbf{Technical food fraud risks} such as mislabelling of the origin or ingredients.

Overall, these sub-categories of food fraud might overlap and should not be interpreted as sharply delineated categories but rather as tools to aid in understanding food fraud activities (van der Meulen, 2015). Nevertheless, these different types of categorisation underline how multifaceted the problem of food fraud is.

Further terms that can be found in the literature on food fraud are \textbf{food defence, food protection, food fraud resilience, food authenticity} and \textbf{food integrity}.

\textbf{Food defence} is by some scholars defined as intentional adulteration of food in order to create harm, in contrast to food fraud, which is considered an intentional act for economical gain (e.g. Manning & Soon, 2016; Spink, 2014). Therefore, the underlying motivation (creating harm versus economic gain) differentiates food defence from food fraud according to these studies. Other scholars propose a wider definition of food defence referring to the methodology and countermeasures taken to prevent and mitigate the effects of intentional incidents and threats to the food chain (Davidson et al., 2017). Closely connected to food defence is \textbf{food protection}, which some authors use as an umbrella term comprising food quality, food safety, food fraud, and food defence (Spink, 2014).

\textbf{Food fraud resilience} is sometimes used to refer to how well organisations protect themselves against fraud (Daly & Gee, 2016)$^5$, while \textbf{food or FSC integrity} is referred to as a multifaceted concept to provide assurance to consumers and other stakeholders about the safety, authenticity and quality of food$^6$. The latter concept encompasses thereby food safety, security, traceability, origin authenticity, quality attributes and product information resulting in a final food product with integrity (Elliott, 2014). In this context, Manning (2016) proposed to differentiate four

$^5$ Resilience in common language refers to the ability to recover from or adjust easily to misfortune or change (https://www.merriam-webster.com/dictionary/resilience)

$^6$ https://secure.fera.defra.gov.uk/foodintegrity/index.cfm
elements of food integrity, namely product, process, people, and data integrity. **Product integrity** refers to the inherent quality attributes of totality or completeness that is to the product’s intrinsic characteristics. **Process integrity** refers to the activities undertaken to produce the food encompassing the design, assurance, monitoring and verification of processes within the product lifecycle to ensure that they remain authentic and intact (extrinsic product characteristics)\(^7\). **People integrity** can be described as the honesty and morals exhibited by an individual and/or group and **data integrity** refers to the consistency and accuracy of information accompanying the food item throughout the supply chain. Thus, fraudulent activities can affect each of these four elements of food integrity.

With regard to food fraud prevention, terms such as **risk**, **vulnerability**, **threats** and **mitigation** are often used. **Vulnerability of a certain FSC** usually refers to the degree to which a system is likely to experience harm due to exposure to a hazard\(^8\) (Füssel, 2007). Vulnerability is thus an assessment of how well or how poorly protected the FSC is against fraud. Put differently, vulnerability is a weak point where fraud is more likely to occur. The terms **risk** and **vulnerability** are often used interchangeably in the literature on food fraud (Silvis et al., 2017). Moreover, vulnerability is not static but may be reduced by mitigation measures which are measures taken to decrease vulnerability to a certain type of fraud in a given supply chain.

To sum up, even though no uniform or harmonised definition of food fraud does exist so far, all existing definitions refer in some way to the violation of legally defined rules or procedures, deception of other stakeholders and the intent to gain a personal or business advantage. Moreover, different types of fraud exist with different severity on public health. With respect to food fraud prevention, different terminologies are used across and within different scientific disciplines (e.g. risk, threat, vulnerability, integrity, authenticity). Nevertheless, disregarding the different terminologies employed, the general aim is to identify possible weaknesses in FSC that might give ground for fraudulent activities and based on this identification to design and implement prevention (mitigation) measures to decrease the likelihood of fraudulent activities. Such a risk or vulnerability assessment is the core of most existing food fraud (prevention) models and will be discussed in more detail in section 4 and 5.

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\(^7\) Intrinsic product characteristics refer to attributes that are part of the physical product (e.g., sensory characteristics, ingredients, nutritional composition), whereas extrinsic characteristics are not part of the physical product and can be modified without changing the characteristics of the product (e.g., price, brand, package, health claims) (Olson & Jacoby, 1972).

\(^8\) A hazard is thereby an existing condition or possible (under current conditions) situation that has the potential to cause harm.
3 Regulatory frameworks and international standards

Food authorities usually regulate FSCs through a mix of different tools such as mandatory laws, legal sanctions, bonds to norms and human capacity building (Bavorová et al., 2014). The following section will provide a brief overview of different regulatory tools implemented both by governments (EU-level, national level) and non-governmental organisations that are considered as highly relevant for the topic of food fraud.

3.1 Governmental actions

3.1.1 EU level

The central legislations that currently govern the EU food chain are (Montanari et al., 2016):

(i) EU Regulation 2017/625 on official controls and other official activities, published in the Official Journal on 7 April 2017, which replaces Regulation (EU) 882/2004,

(ii) EC Regulation 178/2002 which lays down the general principles and requirements of food law, the establishment of the European Food Safety Authority (EFSA) and defines procedures in matters of food safety, and

(iii) Regulation No. (EU) 1169/2011 on the provision of food information to consumers – also known as FIC Regulation.

Article 8 of EC Regulation 178/2002 addresses the protection of consumers’ interests in the European Union (EU) and states that food law shall aim at the protection of the interests of consumers and “shall provide a basis for consumers to make informed choices in relation to the foods they consume. It shall aim at the prevention of: (a) fraudulent or deceptive practices; (b) the adulteration of food; and (c) any other practices which may mislead the consumer”. Food Law Regulation 178/2002 also requires the establishment of a traceability system for all food products stating that the detail of traceability is to be extended also to each ingredient of the food. Traceability is thereby defined as “the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution.” The General Food Law, however, does not state any specific method or technique that food operators have to follow (Dabbene et al., 2014).

Moreover, article 50 of this regulation establishes the rapid alert system for food and feed (RASFF) as a network involving the Member States, the Commission as member and manager of the system and the European Food Safety Authority (EFSA). Whenever a member of the network has any information relating to the existence of a serious direct or indirect risk to human health deriving from food or feed, this information is immediately notified to the Commission under the RASFF. The Commission immediately transmits this information to the members of the network (European Commission, 2016).
The currently adopted Regulation 2017/625 supplements Regulation (EC) No 178/2002 by aiming at: (i) protection of human, animal and plant health and of the environment via veterinary and phytosanitary measures; (ii) consumer protection in the internal market; and (iii) animal welfare along the agri-food chain. The regulation states that these aims are to be achieved via a risk-based approach meaning that competent authorities should perform regular official controls on risks associated with food, feed & animals (Art. 9). New key elements in this regulation are that (i) official controls must be performed in a manner that minimises the burden on businesses and (ii) in order to strengthen the fight against fraud it is required for competent authorities to take into account the likelihood of fraudulent and deceptive behaviours when deciding the appropriate frequency of controls.9

Additionally, in response to the horsemeat scandal, the European Commission set up a **Food Fraud Network (FFN) in 2014**. The aim of this FFN is to allow the EU countries to work in accordance with the rules laid down in Articles 36-40 of the Official Controls Regulation (Regulation 882/2004, rules on administrative cooperation and assistance) in matters where the national authorities are confronted with possible intentional violations of food chain law with a cross-border impact. Moreover, in 2015 the **Administrative Assistance and Cooperation System (AAC)** was implemented as an Information Technology system, developed by the European Commission for EU countries to exchange data in a structured manner regarding non-compliances with food and feed legislation.

Besides, the Commission has the power to coordinate activities throughout the Union (Regulation 882/2004, Article 40), by enabling the recommendations of ad hoc plans aiming to establish the prevalence of hazards in food (Hyde & Savage, 2018). Such coordinate activities result in so-called **coordinated control plans (CCPs)** which have been set up in the aftermath of the horsemeat scandal for horsemeat (2013), honey (2015) and fish (2015). **CCPs** are set up for a limited time-period with the aim better to understand the extent of fraud in certain sectors. As phrased by Hyde and Savage (2018), CCPs perform the function of a day-to-day governance response to perceived food fraud.10

Furthermore, **OPSON operations** have been carried out by INTERPOL and Europol since 2011. These operations are annual law enforcement operations with the objective to protect public health and safety through the seizure of counterfeit or substandard food and beverages and dismantling of the organised crime groups involved in this trafficking. OPSON operations were initiated by INTERPOL and Italian law enforcement authorities as a global response to the growing phenomenon of counterfeit and substandard products (INTERPOL, 2017). During these

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10. Readers with an interest in the details of these CCPs are referred to Hyde and Savage (2018) and the following link: [https://ec.europa.eu/food/safety/official_controls/eu-co-ordinated-control-plans_en](https://ec.europa.eu/food/safety/official_controls/eu-co-ordinated-control-plans_en).

11. *Opson* means food in ancient Greek.
operations, agencies from law enforcement, customs and national food regulatory bodies conduct checks at different retail outlets as well as airports and sea ports to locate and confiscate counterfeit or substandard food products (INTERPOL, 2017). The results of these annual checks are published in an annual report highlighting, among others, the type of seized products and the reason for seizure (INTERPOL & Europol, 2016).

The European Commission has responded also to the rise in food fraud by establishing the **European Anti-Fraud Office (OLAF)** in 1999 – European Commission, 1999/352 – to investigate frauds, including suspicions of fraud concerning agricultural products. The main task of OLAF is to protect the financial interests of the EU against systematic fraud of all kinds (European Anti-Fraud Office, 2014).

### 3.1.2 National level

In **Denmark**, the **Danish Veterinary and Food Administration Flying Squad** is a Food Inspection Task Force that was established in 2006 in the wake of a meat scandal, involving the sale of out-of-date frozen meat. This task force employs forensic accounting which refers to the audit of accounting records in search for evidence of fraud (fraud audit) and a fraud investigation to prove or disprove fraud (Singleton & Singleton, 2010).

In the **UK**, food fraud is addressed by two food crime units, namely the **National Food Crime Unit (NFCU)** that was established by the Food Standards Agency (FSA) in December 2014 and the **Scottish Food Crime and Incidents Unit (SFCIU)** that was established in 2015. Both units were established in order to provide leadership in the prevention, investigation, and disruption of food crime and in the management of food safety incidents nationally (National Food Crime Unit, 2016).

In **Germany**, several initiatives have been set up in order to address food fraud. A national advisory council on food fraud has been established as well as a surveillance system called BeoWarn. Furthermore, a **National Reference Centre for authenticity and integrity in the food chain** was founded at the Max Rubner-Institute (MRI). The new centre will coordinate the research conducted at MRI and other research institutes in the field of food authenticity and act as a national contact point, connecting German expertise with the planned European Reference Centre for food authenticity and integrity and other institutions, advising all those involved\(^\text{12}\).

The **Netherlands** is considered a pioneer in ensuring that compliance and enforcement are considered at the start of the rule-making process. Especially relevant for the case of food fraud seems to be the so-called **Table of Eleven**, which contains eleven different determinants of fraud and has widely influenced other countries’ efforts in this field (OECD, 2010). The Table of Eleven (T\(^\text{11}\)) was developed jointly by the Ministry of Justice and Erasmus University and derives from

academic literature in the areas of social psychology, sociology and criminology, supplemented by the Ministry’s practical experiences and viewpoints on law enforcement. The T11 has been widely used by Dutch policymakers and researchers in the agri-food chain (van Asselt et al., 2016) and will be discussed in more detail in section 4.

3.2 Non-governmental initiatives and standards

Several business-led initiatives have been established in recent years addressing the topic of food fraud.

The Food Industry Intelligence Network (FIIN) is an industry network that was established in 2015, and currently has 21 members in the UK including retailers, manufacturers and food service companies. The aim is to share intelligence on food authenticity.

The Global Food Safety Initiative (GFSI) is a business-driven initiative launched in 2000 for the continuous improvement of food safety management systems to ensure confidence in the delivery of safe food to consumers worldwide13. Key activities of the GFSI are: (i) to specify in its guidance document the requirements for food safety schemes and how these requirements should be implemented, controlled and monitored, and (ii) to drive global change through multi-stakeholder projects on strategic food safety issues14. Since 2016, the GFSI Guidance Document includes new requirements for organisations to have a documented food fraud vulnerability assessment procedure in place and to implement measures to mitigate against the identified vulnerabilities15.

Safe Supply of Affordable Food Everywhere (SSAFE) is a global non-profit membership organisation incorporated in 2006 to help integrate food safety, animal health and plant health across food supply chains to improve public health and wellbeing.

Lastly, the Michigan State University (MSU) Food Fraud Initiative is an interdisciplinary research, education, and outreach organization focusing on all types of fraud that can contribute to public health and economic vulnerabilities and threats. This work is accomplished through collaboration between stakeholders from across industries, agencies, associations and other academics.

With respect to international standards it has been pointed out that at present there are no international standardisation committees (e.g. ISO, CEN12, etc.) dedicated specifically to food authenticity and food fraud (Defra, 2015). This can be explained by the fact that the area is diverse and encompasses a multitude of analytical techniques (e.g. molecular biology, stable isotope ratio analysis, etc.) that would make the formation of a dedicated committee difficult at

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15 http://www.ssafe-food.org/our-projects/
a practical level. However, there are international standards implemented addressing the issue of traceability. As pointed out by Dabbene et al. (2014), the ISO 9000 series for Quality Management Systems contains a number of standards concerning traceability. ISO 22000:2005 specifically addresses the establishment and application of a traceability system that enables the identification of product lots and their relation to batches of raw materials, processing and delivering records. ISO 22005:2007 introduces principles and basic requirements for the design and the implementation of a food (and feed) traceability system. Even if it does not specify how this should be achieved, it introduces the requirement that organizations involved in FVCs have to define information that should be, at each stage, obtained and collected from the supplier and then provided to customers, in addition to product and processing history data.

Besides, there are several private standards addressing the topic of traceability. GlobalG.A.P. and the British Retail Consortium (BRC) Best Practice Guidelines for Traceability, for example, set up requirements for traceability by providing principles of effective traceability system design and guidelines to undertake traceability tests (Dabbene et al., 2014).

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16 [https://www.iso.org/standard/36297.html](https://www.iso.org/standard/36297.html)
4 Analytical frameworks for fraudulent activities in food supply chains

Different scientific disciplines are involved in the analysis of so-called regulatory non-compliance, which is also referred to as economic misconduct, economic opportunism, unethical behaviour\textsuperscript{17} or white collar crime, which denotes criminal acts performed by white collar people who are respected members of the professions (Hirschauer & Zwoll, 2008). Food fraud can be considered as one form of such regulatory non-compliance, misconduct or unethical behaviour\textsuperscript{18}. Thus, instead of considering food fraud as an exogenous phenomenon perpetrated by organised crime groups (Food Mafia), it might in most cases be better understood as an endogenous phenomenon within FSCs where criminal opportunities arise under certain conditions as part of legitimate actors’ routine behaviours (Lord et al., 2017a). Hence, this section aims at providing an overview of the contribution of difference scientific disciplines towards the analysis of regulatory non-compliance in FSCs. These disciplines comprise among others, criminology and economics (e.g. microeconomics, management sciences, institutional and behavioural economics), whereby both disciplines have been influenced by sociological and psychological findings.

4.1 Economic concepts

Several studies have pointed out that misdirected incentives are a major source of food risks and that there are relevant constellations in FSCs where non-transparent markets and ill-enforced rules make non-compliance more profitable than compliance (e.g., Hennessy et al., 2003; Hirschauer et al., 2012). At the same time, it has been argued that the understanding of economic misconduct might be improved if one might consider the underlying decisions as being no different to any other business decisions carried out by economic actors (e.g. Hirschauer & Zwoll, 2008; Lord et al., 2017a; 2017b).

In microeconomics, problems linked with economic misconduct are usually addressed by game-theory analysing incentive problems with principal-agent (PA) models. PA models usually rely on the assumption of rational actors that maximise their self-interest (Braun & Guston, 2003). That is, comparing an agent’s utility in case of compliance to her utility in case of non-compliance, the latter being weighted with a probability of detection (Herzfeld & Jongeneel, 2012). This type of

\textsuperscript{17} No uniform definition of unethical behaviour exists, but an ethical decision might be defined as a decision that is both legally and morally acceptable to the larger community. Conversely, an unethical decision might be defined as a decision that is either illegal or morally unacceptable to the larger community (Jones, 1991).

\textsuperscript{18} The report by the National Food Crime Unit (2016) differentiates between food fraud, food crime and regulatory non-compliance stating that regulatory non-compliance is more common than food fraud or food crime but at their most serious, this may also constitute food crime. The present report acknowledges that there are different scales of regulatory non-compliance. However, since currently no indicator exists when non-compliance turns into food fraud, this section focuses on non-compliance in general comprising all forms of fraudulent activities.
models are based on the economics of crime approach introduced by Becker (1968) predicting that regulated entities comply with a given regulation when they conclude that the benefits of compliance, including averting fines or other sanctions, exceed the costs of compliance. Hence, PA models are used to provide a mental map of the economic incentive situation under consideration by analysing the positions of actors, the distribution of information between them, the different types of rules concerned, the physical opportunities for opportunism, the relevant economic parameters, and the (stochastic) influences from the environment. That is, they can help to understand the options available to FSC actors and the kind of parameters and their linkages determining the actors’ incentives (Hirschauer & Zwoll, 2008).

However, it has been shown that people’s choices are not only motivated by economic self-interest but also by non-economic considerations. These non-economic considerations are also called social preferences or pro-social motivations and comprise among others, altruistic preferences and notions of fairness and reciprocity (e.g. Fehr & Schmidt, 1999; Hirschauer et al., 2012). Thus, economic research, which focuses on the role of trust and benevolence in economic relationships, is also highly relevant for the analysis of food fraud. From a modelling point of view, agent-based models (ABM) can be used to model non-compliance behaviour taking also social factors into account (van Asselt et al., 2016).

In this context, it is important to refer to the concept of bounded rationality. Bounded rationality assumes that decision makers are intendedly rational. Yet, rationality is limited by the cognitive capacities of human beings and it is bounded by the context within which market actors are embedded (Biggart & Beamish, 2003; Jones, 1999). Examples of such cognitive limitations or mental short cuts can be found in a decision makers’ search behaviour, such as the fact that people do not consider all aspects of a decision facing them and might even ignore available information. The implication of bounded rationality is that any decision can be modelled as having two components: the extrinsic incentive structure and bounds on adaptability in the given decision-making situation (Jones, 1999).

Moreover, institutional theory and institutional economics might offer valuable insights for the analysis of economic misconduct. Especially cultural theory might help explaining how aspects of the environment can shape cognitive limits to rationality (Vaughan, 1999). Historically grown institutional frameworks shape national business systems since firms are embedded in the social system, and so a firm’s decision must consider relevant institutional pressures such as government regulations, norms, or peers’ actions within the industry (Liu, 2016; Matten & Moon, 2008). The institutional isomorphism theory (IIT) categorises these pressures into three types: coercive, normative, and mimetic pressures (DiMaggio & Powell, 1983). Coercive pressure originates from official pressures such as governmental regulations, whereas normative pressure

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19 The literature also often refers to these different motivations as material versus non-material motivations.
mainly originates from public attention, meaning that firms tend to adopt practices recognised by public attention to improve their reputation. Mimetic pressure operates through the imitation of peers within the industry. In the context of economic misconduct, mimetic processes might refer to the fact that the relative share of firms performing economic misconduct within a particular industry critically determines the likelihood that peers will also adopt illegal practices (Liu, 2016). Consequently, according to IIT, a firm’s decision to commit economic misconduct does not only depend on profit and cost, but also takes regulatory control, public attention, and the degree of non-compliance within their business environment into consideration.

To sum up, economic misconduct is determined by the individual’s cognitive abilities and constraints, organisational characteristics (structure, processes, tasks), and the organizations’ external environment (institutions, culture). Thus, ideally applied, studies of economic misconduct should take into account all these different factors. However, given data and modelling constraints such as an overall analysis might often not be feasible, at least not in a quantitative way. Thus, an economic incentive analysis might provide first insights that should then be complemented with taking into account non-economic factors in order to avoid deriving wrong policy conclusions (Bavorová et al., 2014; Hirschauer & Zwoll, 2008; Hirschauer et al., 2012).

4.2 Criminological concepts

The two most cited theories in the context of fraud analysis are the Fraud Triangle Theory (FTT) of Cressey from 1950 and the Fraud Diamond Theory (FDT) of Wolfe and Hermanson from 2004 (Abdullahi & Mansor, 2015). Both of them identify the elements that lead perpetrators to commit fraud. According to the FTT, three elements are necessary for individuals to engage in fraudulent and unethical activities: (i) perceived pressure, (ii) perceived opportunity, and (iii) rationalisation. These three elements constitute the fraud triangle, which is illustrated in figure 1 below.

**Figure 1: Fraud Triangle**

(Perceived) pressure refers to the factors that lead to unethical behaviour. Thus, this factor refers to the incentives or motives for committing the fraud. Since this pressure does not need to be real, it is also called perceived pressure. Consequently, different decision makers might perceive
the same objective pressure differently due to differences in their cognitive abilities and constraints. Furthermore, some studies differentiate between personal (individual financial or social pressure), employment (management derived pressure) and external (e.g. stakeholder pressure to give a financial return, social and political environment pressure) pressure (Manning et al., 2016).

The second necessary element for fraud to occur is (perceived) opportunity. Opportunity is created by ineffective control or governance systems that allows an individual to commit fraud.20 Perceived opportunity simply indicates that people will take advantage of circumstances available to them.

Rationalisation is the third element of the FTT and refers to the fact that the perpetrator must formulate some justification for the criminal activity. Without finding excuses or justifications why their behaviour is acceptable, an individual will most likely not engage in fraud (Abdullahi & Mansor, 2015). Moral justification or advantageous comparisons are mechanisms that might be used to cognitively reframe unethical acts (Moore et al., 2012a). Moral justification cognitively reframes unethical acts as being in the service of a greater good, while advantageous comparison exploits the contrast between a behaviour under consideration and an even more reprehensible behaviour to make the former seem innocuous (Moore et al., 2012a).

The Fraud Diamond Theory (FDT) is considered an extension of the FTT by adding a fourth element, namely capability. It has been argued that in order to commit a fraud, the individual/business must have the capability in terms of skills and ability to commit the fraud such as for example the ability to manipulate others (Dilla et al., 2013).

Closely connected to these two concepts are the routine activity theory of Cohen and Felson (1979) and the situational prevention theory. The routine activity theory considers crime as the outcome of the convergence in time and place of motivated offenders, suitable targets and the absence of capable guardians. Situational prevention theory is concerned with understanding the circumstances of crime and in particular the availability of opportunities to commit crime using the principles of routine activity theory (Lord et al., 2017b).

Several scholars pointed out that a routine activity approach seems particularly appropriate for the study of food fraud, since fraudulent activities are usually committed at the workplace and thus directly arise out of the routines of everyday life (e.g. Moyer et al., 2017; van Ruth et al., 2017). Thus, food fraud is framed as a commercial enterprise crime involving legitimate food system actors and businesses who as part of their routine activities need to manage supply, demand, competitors and regulators to maintain enterprise (Lord et al., 2017b). In accordance with the routine activity theory and analogue to the fraud triangle, (food) fraud vulnerability can

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20 In the field of accounting, this is termed as internal control weaknesses.
be defined by the three elements: opportunities, motivations and control measures. The opportunities point out why offenders are able to commit fraud and motivations detail why offenders would want to commit fraud (Coleman, 1987). The control measures in place may counteract the vulnerability resulting from opportunities and motivations. So applying the routine activity and situational prevention theories to food fraud implies analysing the circumstances and conditions that shape non-compliant behaviour and how to potentially intervene with these situations (Lord et al., 2017b). In this context, Lord et al. (2017b) proposed the following framework to analyse food fraud taking into account supply, demand, regulatory and competition factors:

**Figure 2: Conceptual model of determinants of fraudulent business activities**

According to this framework, conditions relating to the nature of supply, demand, regulation and competition can create conducive environments and situations for food fraud to take place. Moreover, decisions and behavioural preferences are shaped by institutional cultures. Thus, the underlying idea is to approach food fraud by understanding the dynamics between individual actions, situational environments and wider structural drivers and pressures in order to be able to set up effective fraud prevention strategies.

Besides, the Table of Eleven (T11) developed by the Dutch Ministry of Justice has already been briefly mentioned in section 3 as a tool to analyse non-compliance behaviour. The T11 consists of 11 factors that are defined in table 2.

![Conceptual model of determinants of fraudulent business activities](source: Own presentation based on Lord et al. (2017b))
### Table 2: Dimensions and factors of the Table of Eleven

<table>
<thead>
<tr>
<th>No.</th>
<th>Dimension</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spontaneous compliance dimension</strong></td>
<td><strong>T1</strong> Knowledge of the regulation(s)</td>
<td>The familiarity with and clarity of legislation among the target group</td>
</tr>
<tr>
<td></td>
<td><strong>T2</strong> Cost/benefit considerations</td>
<td>The tangible/intangible advantages and disadvantages arising from compliance or non-compliance with the regulation(s), expressed in time, money and effort as perceived by the target group (costs are not the fine paid in case of violation, this is incorporated in severity of sanction)</td>
</tr>
<tr>
<td></td>
<td><strong>T3</strong> Extent of acceptance</td>
<td>The extent to which the policy and legislation is considered acceptable by the target group</td>
</tr>
<tr>
<td></td>
<td><strong>T4</strong> General law-adherence</td>
<td>The extent to which the target group respects the authority resulting in willingness to comply</td>
</tr>
<tr>
<td></td>
<td><strong>T5</strong> Non-official control</td>
<td>The risk, as estimated by the target group, of positive or negative sanctions on their behaviour other than by the authorities</td>
</tr>
<tr>
<td><strong>Enforcement dimension</strong></td>
<td><strong>T6</strong> Risk of third part reporting</td>
<td>The risk, as estimated by the target group, that a violation detected by others than the authorities, will be reported to a government body</td>
</tr>
<tr>
<td></td>
<td><strong>T7</strong> Risk of inspection</td>
<td>The risk, as estimated by the target group, of an inspection by the authorities as to whether rules are violated</td>
</tr>
<tr>
<td></td>
<td><strong>T8</strong> Risk of detection</td>
<td>The risk, as estimated by the target group, of a violation being detected in case an inspection is carried out by the authorities</td>
</tr>
<tr>
<td></td>
<td><strong>T9</strong> Selectivity of inspection</td>
<td>The perceived (increased) risk of inspection and detection of a violation resulting from the selection of businesses, persons, actions or areas to be inspected</td>
</tr>
<tr>
<td></td>
<td><strong>T10</strong> Risk of sanction</td>
<td>The risk, as estimated by the target group, of a sanction being imposed if an inspection detects a violation</td>
</tr>
<tr>
<td></td>
<td><strong>T11</strong> Severity of sanction</td>
<td>The severity and nature of the sanction associated with the violation and additional disadvantages of being sanctioned as perceived by the target group</td>
</tr>
</tbody>
</table>

Source: van Asselt et al. (2016)

Five factors belong to the so-called spontaneous compliance dimension and reflect commitment or voluntary compliance, whereas six factors belong to the so-called enforcement dimension reflecting factors that are under the control of the law-enforcing agency (Elffers et al., 2003; van Asselt et al., 2016). Thus, in line with the results presented above, compliance behaviour does not only depend on external factors such as inspection frequency or likelihood of detection, but also on internal factors like the acceptance of the legislation and general law-adherence of individuals and businesses. Furthermore, factor T1 explicitly addresses the awareness and knowledge among the target group about a certain regulation. As stressed by Winter and May (2001), the willingness to comply is insufficient unless regulated entities are also aware of what is desired and are able to carry out the requisite steps. The T11 has been used in several analyses of the Dutch agri-food value chain such as Elffers et al. (2003) who analysed non-compliance among farmers with respect to the application of chemicals and van Asselt et al (2016) who simulated farmers’ compliance behaviour regarding antibiotics legislation. Moreover, the T11 is
used by inspection agencies in the Netherlands to analyse which inspection strategy would be most effective for improving compliance behaviour of target groups (van Asselt et al., 2016).

### 4.3 Major lessons from the theoretical literature

Even though economic misconduct in general and food fraud in particular has been approached by different disciplines, some stylised facts can be summarised. First, all approaches have a common denominator which is that misconduct is considered as a relevant behavioural option of economic actors. This misconduct, in turn, might cause risks for their business partners and other stakeholders such as consumers. Second, all frameworks analyse people’s choices as being motivated by a mix of economic and non-economic factors, embedded in a certain social and institutional environment. As a consequence, existing economic incentives are not considered as sufficient to explain food fraud, since individual and social norms and values may shield actors from committing misconduct despite existing monetary incentives. Therefore, apart from economic aspects, cognitive, social, cultural and institutional factors should ideally also be taken into account as important elements in the analysis of food fraud.

### 4.4 Empirical case studies of analysing non-compliant behaviour in food supply chains

In the following, three different case studies that relate to the analysis of food fraud and that rely on one of the theoretical concepts discussed above will be presented. The first and third case study focus on the economic incentive structure for economic misconduct in the German poultry and the Spanish olive oil supply chain, respectively. The second one analyses mislabelling of rice in Taiwan using the above introduced concept of institutional isomorphism theory (IIT).

#### 4.4.1 Case study 1: Economic incentive analysis for economic misconduct in the German poultry supply chain

Hirschauer and Zwoll (2008) provided an analysis of the economic incentive structure for non-compliance at different levels of the German poultry supply chain. They called this the first stage of research into economic misconduct, since they neither analysed actual behaviour nor qualified the actual choices contingent on the social settings and intrinsic motivations. Nevertheless, revealing economic temptations for non-compliance might help in assessing where problems might arise.

For this purpose they carried out extensive interviews with members of the respective control fields and law enforcement authorities as well as producers, processors, consultants and interest groups. Based on the evidence from these interviews, different types of potential economic misconduct were identified and a formal incentive analysis was carried out for each. The features of the model proposed for the incentive analysis can be summarised as follows:
1. A binary perspective is adopted, meaning that the agent has only the choice between compliance versus non-compliance and there are only two expected outcomes (desired, undesired).

2. \( q \) represents the probability of the desired outcome conditional on compliance, while \( r \) represents the probability of the undesired outcome conditional on non-compliance. Stochastic action-outcome linkages (equivalent to values \( q \leq 100\% \) and \( r \leq 100\% \)) exist, if a physical product quality is the relevant outcome. Whenever labelling issues such as region of origin or organic standards are considered, the linkage is deterministic and \( q \) and \( r \) can be equated to unity.

3. Compliance causes compliance costs \( K \), which usually comprise different components (e.g., increased input costs).

4. Corresponding to the outcome, there are two payoffs. The payoff \( P \), being paid for the desired outcome, and the payoff \( P-L \) being paid if the undesired outcome is disclosed. Losses from disclosure may result from various components such as losses in sales, damage compensation, fines, reputational losses (i.e. long-term market losses).

5. Since inspections are costly, they can only be carried out randomly with an intensity \( s \leq 100 \) per cent (probability of random controls). In other words, an existing outcome irregularity is only identified with a detection probability \( s \leq 100 \) per cent.

6. Incentive problems resulting from incomplete output information may be aggravated in multiple-agent situations. A tracing coefficient \( z \leq 100 \) per cent accounts for situations where an undesired outcome is observed at some (downstream) control point, but the responsible originator is only traced with a certain probability. Whenever the observed outcome can be directly attached to a single agent, the coefficient \( z \) can be set to unity.

Thus, incentives to comply can be expressed as the difference between the expected payoff from compliance minus the expected payoff from non-compliance or more formally\textsuperscript{21}:

\[
\text{Incentives to comply} = [qP + (1 - q)(P - L) - K] - [(1 - r)P + r(P - L)] = (q + r - 1)L - K \tag{1}
\]

Whereby a negative result of (1) implies that the incentive structure fosters non-compliance, since the individual expects to earn higher profits through non-compliance than through compliance. A positive result, in contrast, means that it is more profitable to comply than not to comply. Equation 1 assumes complete inspection and tracing (i.e. if the outcome is observed it is unambiguously attached to the agent). However, in reality given the fact that controls are costly there will be no complete detection and thus, the expected pay-offs need to be adjusted. This is illustrated in equation 2 including the detection probability \( s \) and the tracing coefficient \( z \):

\textsuperscript{21} For more details on the calculations, see Hirschauer and Zwoll (2008).
Incentives to comply = sz \cdot (q + r - 1)L - K, with 0 < sz \leq 1

(2)^{22}

To illustrate the approach, two potential non-compliant activities and their respective incentive analysis are presented in the following table.

Table 3: Economic incentive structure for non-compliance behaviour in the poultry supply chain

<table>
<thead>
<tr>
<th></th>
<th>Use of conventional feed components in organic poultry feeding (Farm level)</th>
<th>Marketing of conventional poultry as organic produce (Retail level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Action-outcome linkages q and r</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability of desired outcome for compliance (q)</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>Probability of undesired outcome for non-compliance (r)</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>(b) Detection probability s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability that an undesired outcome is detected</td>
<td>3 %</td>
<td>6 %</td>
</tr>
<tr>
<td>(c) Compliance costs K (€)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs arising from compliance with the rules</td>
<td>900</td>
<td>202</td>
</tr>
<tr>
<td>(d) Losses L (€)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflicted losses if non-compliance is proven thereof:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short term losses (from sales)</td>
<td>69,004</td>
<td>1,000</td>
</tr>
<tr>
<td>Short-term sanctions (fines, subsidy losses)</td>
<td>44,064</td>
<td>0</td>
</tr>
<tr>
<td>Disposal costs</td>
<td>24,940</td>
<td>1,000</td>
</tr>
<tr>
<td>Capitalized long-term market losses</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(e) Tracing coefficient z</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The responsible actor’s probability of being traced</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>Economic inferiority (-)/superiority(+) of compliance</td>
<td>1,170^a</td>
<td>-142^a</td>
</tr>
<tr>
<td>Ceteris paribus critical level of the inflicted loss (€)</td>
<td>30,000</td>
<td>3,367</td>
</tr>
<tr>
<td>Ceteris paribus critical detection probability</td>
<td>1.3 %</td>
<td>20.2 %</td>
</tr>
</tbody>
</table>

Notes: ^a These numbers are the central outcome of the analysis indicating that non-compliance is either favourable (negative sign) or unfavourable (positive sign).

According to the experts’ assessment, the use of conventional feed for organic poultry is not considered a profitable misconduct option, as can be seen in the positive superiority of compliance. This result is mainly driven by significant sales losses, since in case of detection the farmer would have to sell his poultry as lower-priced conventional poultry. Representing a serious loss, the detection probability could even fall from the assumed level of 3 per cent to a level of 1.3 per cent without jeopardising the incentive compatibility (last row in the table). In contrast, selling conventional poultry as organic at the retail/butcher level is assessed as offering

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^22 Even though the model contains only few parameters, in empirical applications a major challenge is to identify these components and realistically estimate their values or, at least, magnitudes.
economic incentives for non-compliance. The results seem mainly to be driven by the overall low detection probabilities that shape the incentive structure towards non-compliance. In the interviews with the experts from the control field (public authorities), low inspection intensities were often justified (besides budgetary constraints) by the general trustworthiness of most food business operators.

4.4.2 Case study 2: Analysing mislabelling of rice in Taiwan, using the institutional isomorphism theory (IIT)

Liu (2016) investigated mislabelling of rice in Taiwan by drawing on the institutional isomorphism theory (IIT). The Taiwanese rice industry was chosen as a case study since it has been estimated that the proportion of firms mislabelling their products has been constantly fluctuating between 10 and 20 per cent. The leading manufacturer of packaged rice in Taiwan was in August 2013, found to have deceived consumers by using inferior rice from Vietnam as a substitute for quality rice from Taiwan in its renowned Sunsuivi Long Grain Rice. Furthermore, in September of the same year, the Agriculture and Food Agency found that 18 per cent of the products inspected, which were produced by the three major grain dealers, were mislabelled.

A major reason for the incentive to mislabel rice in Taiwan seems to be the governmental policy of acquiring public grain reserves (i.e. the Taiwanese government purchases rice at a guaranteed price each year to build public grain reserves). This guaranteed price drives up the domestic price of Taiwanese rice, causing it to be higher than for rice from other main supply areas such as Thailand, Vietnam, or China. Thus, this price gap between domestic and imported rice led some companies to choose to mix imported rice with local rice and then sell the packaged rice as local rice. Besides, from a regulatory point of view, non-compliant businesses were simply asked to make improvements themselves by a certain deadline without imposing any penalties for non-compliant behaviour.

The empirical analysis had its focus on the period 2008 to 2014, and analysed the causality between these institutional factors and the level of mislabelling. The results of this longitudinal analysis showed that the evolutionary processes behind regulatory control, public attention, and the level of mislabelling are self-reinforcing, i.e., the former statuses of these institutional factors accelerate their future statuses. Furthermore, the degree of mislabelling is not only affected by former levels of regulatory control, public attention and mislabelling, but also modifies the future status of each of these.

In terms of practical implications, the authors conclude the following from their findings: First, regulatory control only remains strong if the level of mislabelling is low, and so in addition to increasing the fine, regulators should also endeavour to monitor such activities more effectively through periodic large-scale inspections of food products. Second, the results suggest that high levels of public attention could lower the degree of mislabelling. Thus, it is important for
consumers’ associations to play an aggressive role in educating consumers or by revising regulations on an ongoing basis in response to consumers’ concerns. Third, a high former level of mislabelling could enhance the future status of mislabelling, which might result in a decrease of the average quality of food in the market. Consequently, although a firm that mislabels its products may receive more profit in the short term, a higher level of mislabelling within the industry will reduce their profit in the long term. Such behaviour might be counteracted by pointing out that ethical business behaviour pays off in the long run, and thus firms should aim to become ethical benchmarks.

4.4.3 Case study 3: Analysis of adulteration and fraud in the Spanish olive oil market

Following the conceptual framework presented in figure 2, Lord et al. (2017b) analysed the incentive structure for fraudulent activities in the Spanish olive oil market. Documented cases of food fraud in the Spanish olive oil market comprise among others, the disguise of sunflower, avocado or palm oil as olive oil, using preservatives and colorants.

In a first step, a chart of the Spanish olive oil production based on interviews with industry actors was set up to understand how different stakeholders/businesses in the Spanish olive oil supply chain operate, interact and make their profit. Additionally, aggregate data relating to production, consumption, imports, exports, market shares and data on price volatility were collected.

According to these data, the Spanish olive oil market can be considered a very complex one (see annex 1), with at the same time few powerful market actors and cartel-like private organisations that appear to control the price of oil. Moreover, the authors identified three significant changes in the production and supply arrangements of olive oil in Spain after the financial crisis in 2007: (i) the growth of second degree cooperatives, (ii) changes to the distribution strategies of large cooperatives and (iii) the increase in retailers’ own brands. The increase in retailers’ own brands concentrated demand, which resulted in fierce price competition that reduced supply chain profit margins. Furthermore, as a consequence of the price volatility during the post-financial crisis, olive oil bottlers and refineries established companies in third countries on the Mediterranean coast in order to diversify supply.

An overview of the identified relevant supply, demand, regulatory and external environmental drivers in the Spanish olive oil market is presented in table 4.

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23 This result, when bad quality pushes good quality from the market because of an information gap or asymmetric information between buyer and seller, is also known as “adverse selection” (Akerlof, 1970).

24 This whole section is based on Lord et al. (2017b). The authors focused on adulteration rather than on other fraud types such as mislabelling or misdescription, or forms of tax and subsidies frauds, although the authors point out that there is often overlap between these fraud types.
**Table 4: Current drivers in the Spanish olive oil market**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Current drivers</th>
</tr>
</thead>
</table>
| Supply | • Concentration of supply by which the bottling of olive oil has become more expensive.  
          • Production exceeds consumption creating a state of perpetual oversupply for domestic markets.  
          • Mills must operate at 'optimum capacity' to be viable which creates surplus.  |
| Demand | • Price volatilities when buying in supply. This leads to confrontation between the traditional industry (bottling and refining) and producers (growers and mills). The power shift to distributor’s own brands has confronted industry (bottling and refining) to distributors at the consumer-end.  |
| Regulation | • Lack of credible regulatory oversight and capable guardianship (a necessary but not sufficient condition).  
              • Business and institutional cultures make prohibited conduct acceptable.  |
| Competition | • Product is stored by dominant cooperatives (essentially cartels under EU law) and released as prices climb to maximise profit, which creates pressure for competitors.  
              • Increases in own brand products, which have led to the concentration of demand, pressures on prices and a reduction on the margins of the whole supply chain due to war prices. Retailers are selling olive oil at a loss to attract clients.  
              • Taking a loss has significant financial impact (false profits/losses) - criminal necessity as a consequence of market practices in order to maintain cash flow.  |

Source: Lord et al. (2017b)

Based on this analysis, the authors conclude that adulteration and illegal blending is unlikely to occur at the production stage of olives but rather at the processing stage. More specifically, it is likely to take place between post-extraction and pre-packaging. Thus, in order to prevent such types of adulteration and illegal blending, potential situational prevention mechanisms might be the increase of the level of non-routine inspection measures in key locations such as mills and refineries. Further prevention mechanisms might be the improvement of due diligence\(^\text{25}\) of suppliers of anomalous products such as a producer of colorants or other untypical ingredients in oil, and a whistleblowing protection system as a tool to increase the risk of detection. Montanari et al. (2016) pointed out that most of the food fraud cases that are detected are denounced by subjects acting in the supply chain.

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\(^{25}\) Due diligence refers to the care a reasonable person should take before entering into an agreement or a financial transaction with another party ([https://www.investopedia.com/terms/d/duediligence.asp](https://www.investopedia.com/terms/d/duediligence.asp)).
5 Existing prevention, detection and mitigation tools

The last section ended with some examples on how an (economic) food fraud incentive assessment could look like. The following section will focus in more depth on existing prevention tools. For this purpose, an overview of existing databases and meta-analyses of food fraud will be provided, followed by a section elaborating which kind of food fraud prevention tools/models currently exist. Since the report focuses solely on social science approaches, laboratory detection methods will not be covered.

5.1 Databases and meta-analyses – extent and patterns of food fraud

Several efforts are ongoing to compile and capture current and historical data on food fraud incidents through the creation of databases and repositories (Johnson, 2014). More specifically, the idea is to create a repository of information that consolidates all relevant historical information to include ingredient, adulterant, source, date of incidence, cost to the firm and actions taken. Thus, these databases and repositories are considered useful tools to identify illegitimate practices applied previously to specific raw materials or food products (retrospective analysis), which in turn might help to identify trends and thus potentially prevent future food fraud incidents (prospective analysis) (Cavin et al., 2016; Moore et al., 2012b).

Table 5 provides an overview of existing databases, repositories and meta-analyses of food fraud incidents.

Table 5: Existing databases, repositories and scientific meta-analyses

<table>
<thead>
<tr>
<th>Category</th>
<th>Provided by</th>
<th>Source of information</th>
<th>Geographical coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Food Adulteration Incidents Registry (FAIR) <a href="https://foodprotection.umn.edu/fair">https://foodprotection.umn.edu/fair</a></td>
<td>Food Protection and Defense Institute (FDPI) at the University of Minnesota</td>
<td>Publicly available sources</td>
</tr>
<tr>
<td></td>
<td>FPDI Economically Motivated Adulteration (EMA) Susceptibility Database <a href="https://www.foodshield.org./discover-tools-links/tools/">https://www.foodshield.org./discover-tools-links/tools/</a></td>
<td>Food Protection and Defense Institute at the University of Minnesota</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rapid Alert System for Food and Feed (RASFF) database</td>
<td>The European Commission</td>
<td>Alerts/notifications by member states or third-part countries</td>
</tr>
</tbody>
</table>

(Cont.)
The **United States Pharmacopeial Convention (USP) Food Fraud database** 2.0 is a database that catalogues available analytical methods to detect and identify problematic food ingredients, which in turn provides a repository for ingredient fraud reports. The database is organised by food ingredient categories and identifies the type of adulterant reported for each documented record.

The **Food Protection and Defense Institute’s Food Adulteration Incidents Registry (FAIR)** is a compilation of historical and current events involving economically motivated and intentional adulteration of foods on a global scale. Data is routinely curated from publicly available sources and includes food adulteration incidents motivated by terrorism, sabotage, and fraudulent economic gain.

The **FPDI EMA Incident Database** catalogues and details a wide range of unique incidents of EMA in 16 different categories. The database is searchable by incident characteristics such as food adulterant, production location, morbidity/mortality, and date.

The **RASFF database** enables information to be shared rapidly and efficiently between the European Commission, food and feed control authorities in Member States and organizations whenever a health risk has been identified. All 27 EU Member States are members of RASFF, together with the European Commission and the European Food Safety Authority (EFSA). Iceland, Liechtenstein and Norway are also full members of RASFF.26

Besides, the Joint Research Centre (JRC) of the European Commission publishes monthly Food Fraud Alerts. These are monthly summaries of articles on food fraud and adulteration, with the objective of informing stakeholders of potential fraud cases in the global feed/food chain, giving them the opportunity to take action to counter fraud. The types of foods being searched for are those on the list of commodities, that are often subject to fraud as defined by the EU Parliament in its resolution of 14 January 2014 on the food crisis, fraud in the food chain and the control

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thereof: olive oil, fish, organic products, grains, honey, coffee, tea, spices, wine, certain fruit juices, milk and meat.

**Extent and patterns of food fraud**

Moore et al. (2012b) and Johnson (2014) summarised data from the USP Food Fraud Database and reported that oils, milk, juices, spices, and sweeteners account for 69 per cent of the reported cases between the years 1980 and 2010, while natural flavours, spices, seafood, and grains/cereals headed the list of food ingredient fraudulent cases. Overall, olive oil, milk, honey, and saffron were the most common targets for adulteration reported in scholarly journals, and potentially harmful issues identified include spices diluted with lead chromate, substitution of Chinese star anise with toxic Japanese star anise, and melamine adulteration of high protein content foods. Based on a media analysis for China, Zhang and Xue (2016) reported that animal foods, processed foods or mixed foods, drinks and beverages, as well as cooking oils were most prone to fraudulent activities. Pardo et al. (2016) focused on mislabelling of seafood and showed that in their sample, on average 30 per cent of controlled products were mislabelled. Incidents in restaurants and takeaways seem to be much more common than in supermarkets and retailers. In addition, they stressed that the available data indicates a remarkable absence of appropriate sampling plans prior to sample collection.

Moore et al. (2012b) also analysed the data in terms of the type of fraud detected. The USP database classifies food fraud into three categories: replacement, addition, and removal. The term replacement refers to cases where authentic material is replaced with another, less expensive, substitute without the purchaser’s knowledge and for the seller’s economic gain. Substitution of dairy fat with palm oil in cheese production is an example of this type of fraud. Addition refers to the addition of non-authentic substance to mask inferior quality ingredient without the purchasers’ knowledge, whereas removal refers to the removal of an authentic and valuable constituent without the purchasers’ knowledge, respectively (Moore et al., 2012b). The replacement category represented 95 per cent of the records in the database, followed by less than 5 per cent for addition and less than 1 per cent for removal.

Tähkäpää et al. (2015) analysed the overall pattern of reported frauds and adulterations for the period 2008-2012 based on RASSF notifications. Besides, notifications published by the Finnish Food Safety Authority (Evira) and local Finnish cases were analysed. According to this study, the share of frauds and adulterations in total notifications and recalls is very low at the EU level (2 per cent out of all RASFF notifications) and relatively low at the national (21 per cent of Evira notifications) and local level (only 16 cases detected) in Finland.

Most frauds were detected via border controls and the most common response from control authorities to non-compliance with regulation according to RASFF notifications was the destruction or re-dispatching of the product. Actions were most commonly taken for seafood, food from farm animals and cereals, nuts, bakery products and confectionery. This might be
due, at least partially, to the quantity of these products imported to the EU, since seafood was the second most common product imported to the EU. With respect to the origin, the data shows that only in 8 per cent of reported fraud and adulteration cases the food originated in the EU. This might indicate that frauds and adulterations mainly occur for foods produced outside the EU. However, it might also indicate that the RASFF system is tailored especially to report non-EU cases of frauds or adulterations, and that cases possibly occurring more commonly in the EU are simply missed by the RASFF system.

This latter aspect is quite important to have in mind while interpreting databases on food fraud in general. It has been pointed out by several scholars that the existing databases may be more representative of foods that are the most researched, and not necessarily foods that are the most adulterated (e.g. Johnson, 2014).

### 5.2 Food fraud prevention tools and models

Several research projects are under way, exploring the possibilities to forecast and thus prevent future fraud incidents. The following section will provide a review of this ongoing research and outline the major models and concepts developed so far. Table 6 provides a list of currently available models of food fraud prevention with their underlying theoretical framework, if available.

**Table 6: Existing food fraud prevention models**

<table>
<thead>
<tr>
<th>Name of the concept/model</th>
<th>Developed by</th>
<th>Theoretical framework</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specific food fraud models</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bayesian Network model to predict food fraud type</td>
<td>Bouzembrak and Marvin (2016); Marvin et al. (2016)</td>
<td>Bayesian Network (BN) approach</td>
</tr>
</tbody>
</table>
| Early Warning system for identification of potential health risks and fraudulent practices in the food sector | Bavarian Health and Food Safety Authority (LGL), Müller et al. (2015) | Horizon Scanning & Root Cause Analysis
| Food Fraud Initial Screening model (FFIS) | Spink et al. (2016a) | Enterprise risk management (ERM) framework |
| Food Fraud Vulnerability Assessment | Cavin et al. (2016), Silvis et al. (2017), Wu et al. (2017) | |
| Food Fraud Vulnerability Concept | van Ruth et al. (2017), van Ruth et al. (2018) | Routine activity theory |
| NSF Fraud Protection Model | NSF (Safety and Quality UK Ltd) (2014) | Fraud Triangle |
| Product-counterfeiting incident cluster tool | Spink et al. (2013) | Routine Activity Theory and Situational Crime Prevention |
| Threat Assessment | National Food Crime Unit (2016) | - |

(Cont.)
<table>
<thead>
<tr>
<th>Name of the concept/model</th>
<th>Developed by</th>
<th>Theoretical framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>General food value chain/food system models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSMANGO vulnerability matrix</td>
<td>Grando et al. (2016)</td>
<td></td>
</tr>
<tr>
<td>Qualitative food system vulnerability matrix</td>
<td>Paloviita et al. (2016)</td>
<td>Systems approach</td>
</tr>
</tbody>
</table>

Notes: 

a Horizon scanning refers to public consultations with experts and stakeholders to identify future risks and prioritise them, in order to develop mitigation measures before problems occur.

Source: Own compilation, in alphabetical order.

Bouzembrak and Marvin (2016) developed a Bayesian Network (BN)\(^{27}\) model in order to **predict the expected food fraud type for imported products for which the product category and country of origin are known**. This model is based on fraud notifications reported in the RASFF database in the period 2000-2013. The developed BN model predicted 80 per cent of food fraud types when food fraud type, country of origin and food category had been reported in RASFF earlier. The model gave the correct prediction in 52 per cent of the cases, when a country or country-food category combination appeared that had not been reported in the RASFF database earlier. **The developed BN model cannot predict food fraud itself but showed good performance in predicting the type of fraud that is reported in RASFF, based on product category and country of origin as input values.**

Marvin et al. (2016) developed this BN model further\(^{28}\). Besides data from the RASFF, they integrated data from the existing literature, other food fraud databases (EMA, 2014) and food fraud expert interviews. Based on these different data sources, the following drivers of food fraud were identified: prices of the fraudulent product at the time of detection, trade volumes of the product between the country of detection and the country of origin (COO), price spikes of the fraudulent product around the period of fraud detection, characteristics of the COO and of the country that detected the incident, such as indices for perceived corruption, food safety, governance, legal system, the press, human development and technology. Based on the developed BN model, the variables COO and product were identified as having the greatest influence on the type of food fraud, followed by notifying country, year, press index of the COO, and the corruption perception index (CPI) of the notifying country.

The proposed **NSF Fraud Protection Model** is based on the fraud triangle and takes into account potential profit and likelihood of detection while opportunity is currently not included (NSF, 2014). This model is supposed to deliver a working framework by which food businesses or regulatory bodies can begin to better anticipate which product lines are most/least likely to be

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\(^{27}\) BNs are a class of probabilistic models originating from the Bayesian statistics and decision theory combined with graph theory, which are able to model dependencies between variables, manage non-linear interactions and integrate different kinds of information such as expert knowledge or measurement data (Ben-Gal, 2007).

\(^{28}\) The authors use food fraud as an example but point out that the developed model can also be of use to model other aspects of FSCs.
targeted by fraudsters. For this purpose, a 4-quadrant Boston Consulting Group (BCG) matrix style framework was developed with the intention to provide a clear visual representation of relative product risk. Depending on the potential profit opportunities and the likelihood of detection, different ingredient categories are assessed for their food fraud risk. Such a risk assessment is illustrated in figure 3.

**Figure 3: Risk assessment of different ingredient categories according to the NSF draft fraud model**

![Risk assessment of different ingredient categories according to the NSF draft fraud model](Image)

Source: NSF (2014), p.32

According to this assessment, the product categories of eggs, herbs and sauces are plotted in the top right quadrant, which is the most desirable scenario for a fraudster (high profit, low likelihood of detection). It has been pointed out that the developed model focuses on organised food crime and is probably less useful where the fraudulent activity takes place for other reasons, such as for example to meet unforeseen shortfall of supply.

Several studies are available that aim at developing and applying a **food fraud vulnerability assessment (FFVA) tool** (Cavin et al., 2016; Silvis et al., 2017; van Ruth et al., 2017, van Ruth et al., 2018; Wu et al., 2017). These concepts rely on or build upon the analytical frameworks presented in section 4, particularly the Routine Activity Theory and Situational Crime Prevention. To recall, the underlying idea is that in order to prevent food fraud it is important to understand existing vulnerabilities in FSCs, since these weaknesses provide opportunities for fraud. Section 4 already introduced the framework proposed by Lord et al. (2017b). A closely related framework by van Ruth et al. (2017) is illustrated in the following figure.
These authors classified opportunities into technical opportunities and opportunities in time and space. Technical opportunities refer to the ease of adulteration/counterfeiting of certain types of products and the general availability of knowledge and technology to adulterate in a particular FSC. Opportunities in time and space refer to the organization of the FSC whereby it is assumed, for example, that fraud opportunities increase when the offender is spatially separated from the victim. Thus, an increasingly complexity of an FSC will enhance the fraud vulnerability (see case study 3 on the Spanish olive oil supply chain and its complexity, presented in Annex 1). With respect to motivational drivers, one might differentiate between economic and non-economic ones, whereas regarding control measure one might distinguish between technical and managerial measures. Overall, more opportunities and motivations increase the fraud vulnerability, whereas control measures can act as countermeasures and decrease these vulnerabilities (Silvis et al., 2017).

A slightly different classification of factors that determine vulnerabilities in FSCs has been proposed by Cavin et al. (2016) and Wu et al. (2017). These authors differentiate between vulnerabilities due to (i) factors inherent to the raw material, (ii) factors impacting the business (Business Pressure), and (iii) factors under the control of the buyer.

**Vulnerabilities driven by factors inherent to the raw material** depend mainly on the physical state of the raw material, its level of processing and its composition. Some raw materials are by nature more vulnerable to adulteration than others. Milk is discussed as one example of a
product that has been highly adulterated worldwide for many years. Its physical state as a liquid makes it easy to adulterate by addition of many adulterants such as water or using milk from foreign species. Moreover, the raw milk price depends on its composition such as protein and fat levels and its microbiological quality. These factors have a strong impact on the milk’s inherent vulnerability to adulteration since many compounds with very different properties can be added to make profit from milk. Thus, it is concluded that the fraud history of a certain ingredient/product (past cases of adulteration of specific raw materials) is a good source of information to assess the raw materials’ potential vulnerability (Wu et al., 2017).

**Vulnerabilities driven by factors impacting the business refer mainly to factors such as**

the demand for a specific raw material (volume), its extent of use (meaning possible application in several finished products and different businesses) or significant market price fluctuations. Any anomaly in the economics of a particular raw material source, such as a drastic price increase or a country-specific low price compared to the rest of the world, might be potential indicators of increased raw material vulnerability due to economic conditions (Wu et al., 2017).

**Vulnerabilities driven by factors under the control of the buyer** refer to the strength or the weakness of a company’s food fraud mitigation strategy. This comprises for example implemented traceability systems, adequate purchasing specifications, availability of analytical methods, and robustness of surveillance programs (Cavin et al., 2016; Wu et al., 2017).

Even though different studies have proposed different categorisations of factors determining vulnerabilities, it is important to point out that all studies address more or less the same set of factors in order to analyse vulnerabilities of FSCs.

A freely available FFVA tool, taking into account the different dimensions and determinants described above, is available on the SSAFE website (http://www.ssafe-food.org/our-projects/). The explicitly stated goal of this tool is to help any food business, irrespective of size or geographic location, to assess their vulnerability to fraudulent activities and prepare mitigation plans. The SSAFE food fraud vulnerability self-assessment is based on 50 questions and answering grids related to the above discussed vulnerability factors. More specifically, 11 questions relate to opportunities, 20 to motivations and 19 to control measures (van Ruth et al., 2017). Annex 2 provides a detailed table with the included questions and potential answers. The practical application of this tool is illustrated in two case studies presented below (5.2.1 and 5.2.2).

A vulnerability assessment, however, is only a first step in setting up a business or governmental food fraud prevention strategy. Such an assessment needs to be complemented with mitigation measures to decrease the likelihood of fraudulent activities. Hence, a complete food fraud management system, analogue to any other risk management system should be implemented, and several companies have already implemented such a system. Nestlé for example, published a booklet on food fraud prevention with the purpose to provide guidance to food operators on
how to assure the authenticity of food by minimizing vulnerability to fraud and mitigating the consequences of food fraud (Nestlé, 2016). With regard to a food fraud management system it is argued that food fraud should simply be handled and managed as any other business risk, involving the assessment of the risk (or vulnerability in this case), followed by setting up, reviewing and implementing appropriate mitigation strategies. Furthermore, given the fact that vulnerabilities might change over time, this process needs to be repeated either periodically or in case significant changes occur (e.g. price anomalies, supply shortage of raw materials).

Potential mitigation measures a company can take include among others: strict raw material monitoring (e.g. setting up of specification and surveillance measures to ensure authenticity) and tight relationships with suppliers (“know where your raw materials are coming from”) in order to increase transparency and traceability in the supply chain.

For the sake of completeness, table 6 also lists models specifically designed for assessing food system vulnerability in general. These are the **TRANSMANGO vulnerability matrix** and the **Qualitative food system vulnerability matrix**. Both models aim at obtaining a comprehensive picture of the effects of the global drivers of change on European and global food demand and on raw material production. Thus, they focus on the vulnerability and resilience of European food systems in a context of socio-economic, behavioural, technological, institutional and agro-ecological change and aim to enhance understanding of the new challenges and opportunities that the food sector will face in the future.

**5.2.1 Case study 4: Vulnerability assessment in the spices supply chain**

Silvis et al. (2017) applied the SSAFE FFVA tool described above and presented in detail in annex 2 in order to assess the fraud vulnerabilities of various actors in the spices supply chain. Spices were chosen because they are frequently reported to be adulterated. Eight companies, all members of the European Spices Association (ESA), participated in the study: a trader, two importers, two business-to-business companies, and three business-to-business/business-to-consumer enterprises.

The results of the FFVA are illustrated in the following spider web diagrams (figure 5.)
According to the assessment, the ease of adulterating spices combined with the complexity of fraud detection (indicators 1 to 5) creates considerable opportunities to commit fraud (high vulnerability). Thus, one of the reasons why companies buy spices from their suppliers in their whole form (not milled) is because they wish to ensure that the material is free from adulterants. Opportunities associated with supply chain transparency and fraudulent incidents in the past were judged as medium vulnerable. Strong competition (indicator 30) and the high added value of spices (indicator 12) are perceived as important economic drivers to commit fraud (high vulnerability). In contrast, cultural and behavioural factors such as ethical business culture (indicators 16, 21, 22, 28) were considered to contribute less to the actual fraud vulnerability. With respect to control measures, the results indicate that many of the indicators such as Fraud control industry, Specificity national food policy and Law enforcement chain network (indicators 46-49) scored 1, indicating a high vulnerability. The authors elaborate further that most interviewees perceived that laws and policies that address particular fraud issues are not actively enforced in their country.

5.2.2 Case study 5: (Dis)similarities in fraud vulnerability across supply chains
Van Ruth et al. (2018) aimed at providing insights on the (dis)similarities in fraud vulnerability across supply chains and actor groups, which might help to combat future food fraud. For this purpose, they assessed the fish, meat, milk, olive oil, organic bananas, and spice supply chains
for their fraud vulnerabilities, using the SSAFE FFFVA tool. The analysed stakeholder groups included wholesalers, processors, and retailers.

Overall, some drivers were assigned high scores (high vulnerability) across all different supply chains. These drivers are: available technology and knowledge about adulterating raw materials/final products, fraud detectability in raw materials/final products, historical evidence of fraud in raw materials/final products, supply and pricing of raw materials, valuable components or attributes of raw materials, the corruption level in the supplier country, economic conditions and the level of competition in the industry, and price asymmetries. In contrast, the results indicate that control measures varied considerably across supply chains and actor groups, with technical controls generally being more in place than managerial controls. Managerial controls in a wider sense, i.e. social control and food policy and enforcement, were perceived as lacking or insufficient in many cases. Moreover, fraud vulnerability appeared highest for the spice chain, which was followed by the olive oil, meat, fish, milk and organic banana chains. Among the actor groups, the wholesale/traders group appeared most vulnerable, followed by retailers and processors.

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29 These supply chains were chosen because most detected food fraud cases were found for these products (see section 5.1.).
6 Discussion and conclusions

The present report aimed at reviewing the theoretical as well as the empirical literature on food fraud, in order to provide a solid knowledge base for further discussions among policy makers, regulatory bodies, private businesses and scientists on how to approach fraudulent activities in food supply chains.

Overall, economic and criminological concepts related to the prevention and detection of regulatory misconduct are highly relevant for addressing food fraud. More specifically, the routine activity theory and the economics of crime approach are important frameworks to consider, while setting up cost-effective prevention and detection strategies. In this line, it has been pointed out, that food fraud might be addressed and analysed, as any other business decision, taking into account the incentive structure for regulatory compliance versus non-compliance.

Moreover, companies and regulatory agencies should address food fraud as any other food risk via a risk-based approach. In the context of food fraud, the term vulnerability is often used instead of risk and thus a vulnerability (risk) assessment should be a first important step in setting up prevention strategies. Based on this vulnerability assessment, mitigation strategies to reduce these vulnerabilities need to be designed and implemented in order to decrease the likelihood of fraud. Thus, a food fraud management system should be considered as an integral part of a company’s overall risk management system.

The existing literature has pointed out several important micro- and macro-level factors that seem to primarily determine vulnerabilities in FSCs. These are the ease and detection of adulteration, the presence of added value claims, such as organic or PDO/PGI labels, demand exceeding supply, and the complexity of the value chain (low transparency increases vulnerability).

Additionally, existing empirical evidence indicates that existing legal enforcement powers were not used to their full extent and control officials’ orders would be more effective if the sanctions for disobeying were rapid and sufficiently severe. In this context, it has been argued that fines are only one element of a food fraud fighting strategy, which should also include other elements such as the withdrawal of licenses and authorisations, as well as naming and shaming-techniques, and human capacity building measures (Bavorová et al., 2014).

Moreover, it has been pointed out that consumers are important actors in food fraud detection since they can be viewed as auditors in food markets, contributing to horizontal scanning and intelligence sharing (Wang et al., 2017). Dabbene et al (2014) for example pointed out that consumers can and should be involved and become part of traceability systems in order to
increase and broaden the monitoring activities of suspicious transactions. Thus, consumers should not only be considered as the ones negatively affected by food fraud but also as important stakeholders to detect and prevent food fraud.

Consequently, the report recommends the following points:

First, since resources for inspections and analytical investigations are limited, a **vulnerability risk-based approach should be the guiding principle to set-up governmental control and inspection plans.** There have been several first studies investigating vulnerabilities across different supply chains and stakeholder groups highlighting determinants of fraudulent activities. These studies should build the basis for ongoing empirical research providing ground for risk- (vulnerability)-based control and governance approaches in terms of cost-effective sampling and control schemes.

Second, since **food fraud is a complex and multifaceted topic that can and should be addressed by different scientific disciplines**, a **potential working group on food fraud need to take this complexity into account.** Put differently, natural scientists with knowledge about up-to-date analytical techniques to detect fraud need to work closely together with scientists coming from social sciences, such as economics, sociology or criminology, to set up appropriate prevention strategies. This is true both for the governmental as well as for the business level.

Third, **each stakeholder group in food supply chains should consider food fraud as any other business risk and thus address it within their risk management system.** Such a business behaviour might be fostered by a governmental information campaign, pointing out the importance of an appropriate food fraud management system and potentially providing a guidance document on the issue similar to the booklet provided by Nestlé (2016). Furthermore, a governmental information campaign highlighting the different forms of food fraud, and whom to contact in case consumers detect signs of fraudulent activities, might enable consumers to actively take part in an overall food fraud prevention strategy.

Fourth, **traceability plays a central role in ensuring authentic food products.** Thus, possibilities to foster traceability and increase food integrity should be prioritised both by businesses as well as by governmental agencies. Since private standards are playing an increasing role in the governance of agricultural and food supply chains (e.g. GLOBALG.A.P.), **public-private partnerships to tackle food fraud as one of several food risks supply chain actors face seem to be a very promising approach.**

Fifth, **scientifically grounded cost-benefit analyses are needed to avoid costly overregulation.** As is the case for other (food) risks, setting up prevention strategies are costly and thus cost-benefits analyses are necessary to guide governmental agencies. This is especially important with regard to stakeholder acceptance of regulations governing food fraud. As was highlighted in the
Table of Eleven, stakeholder awareness and acceptance of a certain regulation are central to a successful implementation.
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http://doi.org/10.1016/j.biosystemseng.2013.09.006


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Annex 1. Flow chart of the olive oil production chain

Source: Lord et al. (2017b)
## Annex 2: Questionnaire with answer grids of the SSAFE FFVA tool

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Reason for Asking the Question</th>
<th>Answer option 1</th>
<th>Answer option 2</th>
<th>Answer option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Is it simple or complex to adulterate your raw materials?</td>
<td>Easy alteration of the composition of the raw materials provides opportunities for potential offenders to commit fraud</td>
<td>• Composition of the raw materials cannot be modified and products can only be replaced, i.e. it concerns large objects such as fruit</td>
<td>• Composition of the raw materials can be modified by mixing with low-quality product-own material or foreign material, i.e. as is feasible with ground products (e.g. powders, ground beef, etc.)</td>
<td>• Composition of the raw materials can be modified by mixing with low-quality or foreign material (e.g. powders, ground meat, etc.) and by altering valuable food components (e.g. protein content)</td>
</tr>
<tr>
<td>2</td>
<td>Is the technology and knowledge to adulterate your raw materials generally available?</td>
<td>Technology, methods and knowledge to adulterate/modify a certain type of raw materials provides opportunities for potential offenders to commit fraud</td>
<td>• Technologies and/or methods to adulterate the raw materials are neither available, known, or reported</td>
<td>• Advanced technologies, methods, facilities and knowledge are required to adulterate the raw materials</td>
<td>• Simple/basic technologies and methods are available, and no specialist facilities are required, to adulterate the raw materials</td>
</tr>
<tr>
<td>3</td>
<td>How easily can adulteration of your raw materials be detected and with what kind of methods?</td>
<td>Fraud detection is impeded when analysis of raw materials requires advanced laboratory methods and facilities or if methods are lacking, which in turn provide opportunities for potential offenders to commit fraud</td>
<td>• Detection of adulteration of raw materials is straightforward and performed with common/simple methods (e.g. visual inspection, smelling)</td>
<td>• Established on-site methods are available for fraud screening (e.g. test kits) but confirmation of adulteration requires additional testing</td>
<td>• Detection and confirmation of adulteration of raw materials requires advanced laboratory analysis, or testing for adulteration is not available at all</td>
</tr>
<tr>
<td>4</td>
<td>How available is the technology and knowledge to enable the adulteration of your final products?</td>
<td>Generally available technology, methods and knowledge to adulterate/modify final products provides opportunities for potential offenders to commit fraud</td>
<td>• No technologies and/or adulteration methods are known or available to adulterate final products</td>
<td>• Advanced technologies, methods, facilities and knowledge are required to adulterate final products</td>
<td>• Simple/basic technologies and methods are available, and no specialist facilities are required, to adulterate final products</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• The knowledge required for adulteration is generally available</td>
</tr>
<tr>
<td>5</td>
<td><strong>How easily would adulteration of your final products be detected and what kind of methods are available?</strong></td>
<td>Fraud detection is impeded when analysis of final products requires advanced laboratory methods and facilities or if methods are lacking, which in turn provides opportunities for potential offenders to commit fraud</td>
<td>• Detection of adulteration of final products is easy and performed with common/simple methods (e.g. visual inspection, smelling)</td>
<td>• Established on-site methods are available for fraud screening (e.g. test kits) but confirmation of adulteration requires additional testing</td>
<td>• Detection and confirmation of adulteration of final products requires advanced laboratory analyses, or testing for adulteration is not available at all</td>
</tr>
<tr>
<td>6</td>
<td><strong>How simple or complex is counterfeiting of your final product?</strong></td>
<td>The ease of counterfeiting of a product and general availability of technology/methods/facilities/knowledge to do so provides opportunities for potential offenders to counterfeit</td>
<td>• It is complex to counterfeit the product and technologies, methods, facilities and knowledge are not generally available</td>
<td>• The product can be counterfeited but this requires advanced technologies, methods, facilities and/or knowledge</td>
<td>• The product can easily be counterfeited and technologies, methods, facilities and knowledge are generally available</td>
</tr>
<tr>
<td>7</td>
<td><strong>How easily can counterfeiting of your final product be detected and what kind of methods are available?</strong></td>
<td>Detection of counterfeit products is impeded when analysis requires advanced laboratory methods and facilities or if methods are lacking, which in turn provides opportunities for potential offenders to commit fraud</td>
<td>• Detection of counterfeit products is easy and performed with common/simple methods such as by visual inspection or smelling</td>
<td>• Established and on-site methods are available for counterfeit screening (e.g. test kits) but confirmation of counterfeiting requires additional testing</td>
<td>• Detection and confirmation of counterfeiting requires advanced laboratory analyses, or testing for counterfeiting is not available at all</td>
</tr>
<tr>
<td>8</td>
<td><strong>How would you describe the production lines / processing activities of your company?</strong></td>
<td>Production lines and processing activities which require frequent modification and allow easy interference, or include shifts without strict control and unauthorised access of personnel provide opportunities for potential offenders to commit fraud</td>
<td>• Production lines and processing activities are characterised by continuous flow processes and minor equipment modifications between batches, with only authorised personnel access both day and night</td>
<td>• Production lines and processing activities are characterised by large batches with minor equipment modifications between batches (repetitive flow), with the opportunity for unauthorised access to equipment but no night processing</td>
<td>• Production lines and processing activities are characterised by relatively small batches with major modifications between batches (intermittent flow), and the opportunity for unauthorised access both during day and night</td>
</tr>
<tr>
<td>9</td>
<td><strong>How would you describe your part of the food supply chain?</strong></td>
<td>A complex supply chain that lacks transparency, with short-term/ad-hoc relationships, and no/limited information exchange provides opportunities for fraud</td>
<td>• The Supply chain is transparent, with good insight into suppliers and customers</td>
<td>• The supply chain is not fully transparent; only direct suppliers and customer are known</td>
<td>• The supply chain is complex and lacks transparency; typically customers and suppliers are geographically disbursted</td>
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<td>• Business relationships are long-term relationships and characterised by trust</td>
<td>• Business relationships are variable; some relationships are long-term, others short-term</td>
<td>• Business relationships are ad-hoc and price is the main driver for selecting suppliers</td>
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<td>• The supply chain is integrated, well-coordinated, with comprehensive information exchange across the supply chain</td>
<td>• Some degree of integration exists across the supply chain; information exchange occurs mainly with direct suppliers and customers</td>
<td>• No information exchange occurs between direct suppliers and customers</td>
</tr>
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</table>

| 10 | **Have fraudulent incidents of similar raw materials been reported?** | Reported fraudulent incidents with similar raw material, often accompanied by media attention, indicate opportunities for fraud | • No fraudulent incidents related to raw materials are known | • A few fraudulent incidents have occurred with specific raw materials | • Many fraudulent incidents have occurred with specific raw materials |
|   |   |   | • No documented evidence/information of fraud is available | • Limited documentation and few/no media reports are available | • Incidents are well known and documented, and have received substantial media attention |

| 11 | **Have fraudulent incidents of similar final products been reported?** | Reported fraudulent incidents with similar final products, often accompanied by media attention, indicate opportunities for fraud | • No fraudulent incidents related to any final products are known | • A few fraudulent incidents have occurred with specific final products | • Many fraudulent incidents have occurred with specific final products |
|   |   |   | • No documented evidence/information of fraud is available | • Limited documentation and few/no media reports are available | • Incidents are well known and documented, and have received substantial media attention |

<p>| 12 | <strong>How would you define the supply and pricing of your raw materials?</strong> | Economic pressures on raw materials can motivate offenders to commit fraud | • Raw materials are readily available | • Stable prices but the supply of raw materials is not readily available | • Tight global supplies of raw materials and/or shortages exist |
|   |   |   | • No export bans on raw materials exist | • Export bans on raw materials exist | • Export bans on raw materials exist in many countries |
|   |   |   | • Prices for raw materials are stable | • Export bans on raw materials exist in a few countries | • Price spikes of raw materials are common |
|   |   |   | • Pricing of raw materials is independent of geographical origin | • Large differences in prices of materials from different geographical regions | • Prices of substitute raw materials vary greatly |
|   |   |   | • Prices of substitute raw materials are equivalent |   |   |
| 13 | Do special attributes or components determine the value of your raw materials? | Value added by the composition of raw materials (e.g. protein content), production methods (e.g. organic) and/or geographical origin can motivate offenders to commit fraud | • The value of raw materials is not determined by its composition, way of production or origin | • The value of raw materials is influenced by its composition (e.g. protein or fat content) | • Value of raw materials is greatly determined by its composition, way of production and/or origin |
| 14 | How would you describe the economic condition of your company? | The economic situation of a company can motivate employees to commit fraud for economic survival | • The company is profitable, achieving its financial goals | • Profits are declining and there is a gap between financial targets and actual performance | • There are financial losses and it is difficult to meet financial targets |
| 15 | What are the characteristics of the business strategy of your company? | Short-term financial goals, with strong emphasis to achieve such goals and without specifying the (legitimate) means by which to achieve them can motivate employees to commit fraud | • Long term financial targets, coupled with food quality and safety goals, and the means by which the objectives should be achieved, are well specified | • Financial targets and food quality and safety goals are ambiguous | • There’s a lack of clarity about the means to achieve these objectives |
| 16 | How would you describe the ethical business culture of your company? | A poor ethical business culture can motivate employees to commit fraud | • Mutual trust, interest &amp; respect between all employees across the company | • Mutual trust, interest and respect generally exists among employees but not across the entire company | • There’s a lack of mutual trust, interest &amp; respect among employees |
|   |   |   | • Standards, codes and requirements are taken seriously by all employees | • Not all employees take standards, codes and requirements seriously but many do | • Standards, codes and requirements are not taken seriously across the company |
|   |   |   | • Discussions on unethical conduct &amp; moral issues/dilemmas are common | • Discussions on unethical conduct &amp; moral issues/dilemmas is limited to major incidents only (i.e. ad hoc) | • There are no discussions on unethical conduct &amp; moral issues/dilemmas |
| 17 | Has your company been involved in criminal offences previously? | Companies that committed criminal offences previously have a higher risk of committing future offences | The company has not committed criminal offences or broken the law in the past | There is no information whether the company has committed criminal offences or broken the law in the past | The company has committed criminal offences and/or broken the law in the past |
| 18 | How would you rate the corruption level (according to the Transparency International Corruption Perception Index) in the countries where your company is active? | High levels of corruption in a country increases the risk of fraud | The company is active in countries with low levels of corruption (rated 1-25 on the Index) | The company is active in countries with medium levels of corruption (rated 26-75 on the Index) | The company is active in countries with high levels of corruption (rated 76 and above on the Index) |
| 19 | How would you describe the financial strains imposed by your company on your direct supplier(s)? | Financial strains imposed by companies on their direct supplier(s) can motivate the supplier to commit fraud | The company sets fixed prices for direct supplier(s) in line with market prices, and supplier(s) have other customers | The company typically buys from suppliers that offer the lowest price and suppliers are somewhat dependent on the company for their financial survival | The company always buys from suppliers that offer the lowest prices and suppliers are completely dependent on the company for their financial survival |
| 20 | How would you describe the economic health of your direct supplier(s)? | The economic situation of the company can motivate the supplier(s) to commit fraud for economic survival | The supplier(s) is profitable and achieving its financial targets | The supplier(s) profits are declining, and there is a gap between their financial targets and actual performance | There are financial losses and it is difficult to meet financial targets |</p>
<table>
<thead>
<tr>
<th></th>
<th><strong>What are the characteristics of the business strategy of your direct supplier(s)?</strong></th>
<th>Short-term financial goals, with strong emphasis to achieve such goals and without specifying the (legitimate) means by which to achieve them can motivate suppliers to commit fraud</th>
<th>• Long term financial targets, coupled with food quality and safety goals, and the means by which the objectives should be achieved, are well specified</th>
<th>• Financial targets and food quality and safety goals are ambiguous, and there’s a lack of clarity about the means to achieve these objectives</th>
<th>• There is a strong emphasis to achieve (short-term) financial goals, while the means to achieve them legitimately is not specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td><strong>How would you describe the ethical business culture of your direct supplier(s)?</strong></td>
<td>Poor ethical business culture of companies can motivate potential offenders to commit fraud</td>
<td>• Mutual trust, interest &amp; respect between all employees across the company</td>
<td>• Mutual trust, interest and respect generally exists among employees but not across the entire company</td>
<td>• There’s a lack of mutual trust, interest &amp; respect among employees</td>
</tr>
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<td>22</td>
<td></td>
<td></td>
<td>• Standards, codes and requirements are taken seriously by all employees</td>
<td>• Not all employees take standards, codes and requirements seriously but many do</td>
<td>• Standards, codes and requirements are not taken seriously across the company</td>
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<td>• Discussions on unethical conduct &amp; moral issues/dilemmas are common</td>
<td>• Discussions on unethical conduct &amp; moral issues/dilemmas is limited to major incidents only (i.e. ad hoc)</td>
<td>• There are no discussions on unethical conduct &amp; moral issues/dilemmas</td>
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<td>• Reports on unethical conduct are always taken seriously, and corrections of unethical activities are encouraged and acknowledged</td>
<td>• Reports on unethical conduct are not taken seriously by all employees, and corrections of unethical conduct are not broadly acknowledged</td>
<td>• Reports on unethical conduct are usually ignored, and corrections of unethical activities are neither encouraged nor acknowledged</td>
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<td>• Ethical conduct is highly valued and rewarded by senior management</td>
<td>• Ethical conduct is not equally valued, nor rewarded by senior management</td>
<td>• Ethical conduct is neither valued nor rewarded by senior management</td>
</tr>
<tr>
<td>23</td>
<td><strong>Has your direct supplier(s) been involved in criminal offences previously?</strong></td>
<td>Companies that committed criminal offences previously have a higher risk of committing future offences</td>
<td>• The supplier has not committed criminal offences or broken the law in the past</td>
<td>• There is no information whether the supplier has committed criminal offences or broken the law in the past</td>
<td>• The supplier has committed criminal offences and/or broken the law in the past</td>
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<tr>
<td>24</td>
<td>Has your <strong>direct supplier(s)</strong> been a victim of food fraud committed by their suppliers, customers or other parties?</td>
<td>When a direct supplier has been a victim of food fraud there is a higher risk to your company</td>
<td>• The supplier has not been a victim of food fraud in the past</td>
<td>There is no information available as to whether the supplier has been a victim of food fraud in the past</td>
<td>The supplier has been a victim of food fraud in the past</td>
</tr>
<tr>
<td>25</td>
<td>How would you rate the corruption level (according to the Transparency International Corruption Perception Index) in the countries where your <strong>direct supplier(s) and customers are active</strong>?</td>
<td>High levels of corruption in a country increases the risk of fraud</td>
<td>• Suppliers and customers are active in countries with low levels of corruption</td>
<td>• Suppliers and customers are active in countries with medium levels of corruption</td>
<td>• Suppliers and customers are active in countries with high levels of corruption</td>
</tr>
<tr>
<td>26</td>
<td>How would you describe the economic health across your sector of the food supply chain (i.e. your company and your direct competitors)?</td>
<td>The economic situation across your sector can motivate offenders to commit fraud</td>
<td>• The company operates in a growing market(s)</td>
<td>• The company operates in a stable market</td>
<td>• The company operates in a declining market(s)</td>
</tr>
<tr>
<td>27</td>
<td>Has your <strong>customer(s)</strong> been involved in criminal offences previously?</td>
<td>Customers that committed criminal offences previously have a higher risk of committing future offences</td>
<td>• The supplier has not committed criminal offences or broken the law in the past</td>
<td>• There is no information whether the customer has committed criminal offences or broken the law in the past</td>
<td>• The customer has committed criminal offences and/or broken the law in the past</td>
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<td>How would you describe the ethical business culture across your sector of the food supply chain (i.e. your company and your direct competitors)?</td>
<td>Poor ethical business culture in a branch of industry can motivate potential offenders to commit fraud</td>
<td>• Branch of industry culture is characterised by a high level of mutual trust and respect, ethical discussions and ethical conduct is highly valued between companies</td>
<td>• Branch of industry culture is characterised by overall mutual trust, limited and ad hoc ethical discussions and ethical conduct is moderately valued between companies</td>
<td>• Branch of industry culture is characterised by lack of mutual trust &amp; interests, restricted/no moral/ethical discussions and ethical conduct is not valued between companies</td>
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<td>29</td>
<td>How common are criminal offences across your sector of the food supply chain? (i.e. your company and your direct competitors)?</td>
<td>Criminal offences that have occurred previously across the sector have a higher risk of reoccurring and impacting your company</td>
<td>• There is no evidence of fraudulent activity or other forms of law breaking in our sector</td>
<td>• There may have been incidents of fraud across the sector but there is no specific information available</td>
<td>• There is well-known and documented evidence of fraudulent activity across our sector of the food industry</td>
</tr>
<tr>
<td>30</td>
<td>How would you rate the level of competition across your sector of the food supply chain (i.e. your company and your direct competitors)?</td>
<td>A high level of competition in a sector of the food industry may result in difficulties to reach financial goals by legitimate means, which can motivate potential offenders to commit fraud</td>
<td>• Low levels of competition across the sector</td>
<td>• Medium levels of competition across the sector</td>
<td>• Highly competitive sector of the food industry</td>
</tr>
<tr>
<td>31</td>
<td>Are there price differences as a result of regulatory differences across countries?</td>
<td>Price differences as a result of different regulation across countries can motivate potential offenders to commit fraud</td>
<td>• The price policy of food ingredients and food products is similar for all countries</td>
<td>• The price policy of food ingredients and food products is different in some countries</td>
<td>• The price policy of food ingredients and food products varies considerably across different countries</td>
</tr>
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<td></td>
<td>How would you rate your company's raw material monitoring control systems' ability to detect fraud?</td>
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<td>Detectability of adulterated and/or suspicious raw materials is enhanced when companies have a structured incoming material control system that includes: an evidence-based sampling plan for fraud detection; accurate and specific fraud detection methods; specific fraud monitoring procedures; and systematic record-keeping and documentation as an integral part of their FSMS.</td>
<td>- Sampling plan only for safety and quality analyses but not for fraud check.</td>
<td>- No systematic ad-hoc sampling for fraud analysis.</td>
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<td>- No methods for fraud detection in place; external fraud analysis only in case of inspection demands/fraud issues.</td>
<td>- General screening (quick) methods in place but no (external) confirmatory fraud testing.</td>
<td>- Specific fraud screening methods and systematic use of fit-for-purpose confirmatory techniques (in house or in collaboration with accredited laboratories).</td>
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<td>- No procedures for fraud monitoring tasks.</td>
<td>- General procedure for sampling and screening for monitoring of ingredient/raw material fraud issues.</td>
<td>- Customised procedures for fraud monitoring and handling of non-conformities.</td>
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<td>- No record keeping on adulterated or suspicious raw materials, and no documentation of fraud procedures.</td>
<td>- Record-keeping in case of deviations; limited documentation on fraud monitoring procedures/systems.</td>
<td>- Systematic record keeping and detailed documentation of fraud monitoring procedures &amp; systems.</td>
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<tr>
<th></th>
<th>Are the fraud monitoring tasks of your raw material control system verified in your company?</th>
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<tr>
<td></td>
<td>Systematic verification of fraud monitoring tasks at incoming material control, i.e. based on document &amp; record analysis, observations, and actual testing by an autonomous controller enhances discovery of non-compliance practices is enhanced and assures adequate performance of the fraud monitoring tasks.</td>
<td>- No verification of fraud monitoring tasks at incoming material control.</td>
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<td></td>
<td>- Ad-hoc reporting of verification outcomes; mainly in case of deviations.</td>
<td>- Systematic and comprehensive verification (document &amp; record analysis, observations, and actual testing), unannounced and performed by autonomous controller of fraud monitoring tasks.</td>
</tr>
<tr>
<td>34</td>
<td>How would you describe the fraud related parts of your final product monitoring control system of your company?</td>
<td>A structured monitoring system for fraud detection in final products with an evidence-based sampling plan for fraud detection, accurate and specific fraud detection methods, and fraud-specific procedures and systematic record-keeping and documentation as integral part of their FSMS enhances detectability of internal fraudulent practices</td>
</tr>
<tr>
<td>35</td>
<td>Are the fraud monitoring tasks of your final product control system verified in your company?</td>
<td>Systematic verification of compliance to final product monitoring tasks (sampling, laboratory analysis, corrective actions, record-keeping &amp; documentation) based on document &amp; record analysis, observations, and actual testing by an autonomous controller (no conflicting interest) enhances discovery of systematic deviations</td>
</tr>
<tr>
<td>36</td>
<td>How extensive is the information system for internal control of mass balance flows in your company?</td>
<td>Systematically collected, accurate information on mass balance flows of all raw materials, ingredients, and final products throughout the company</td>
</tr>
<tr>
<td>37</td>
<td><strong>How extensive is the tracking &amp; tracing system of your company?</strong></td>
<td>An integrated tracking and tracing system including clearly defined traceability resource units, collection of accurate and fraud-relevant information from direct supplier up to direct customer (one up - one down), and a robust data capturing and data retrieval system, enhances tracing and tracking of suspicious products/batches, and limits (safety, economic, brand) damage in case of fraud</td>
</tr>
<tr>
<td>38</td>
<td><strong>Is integrity screening of employees common procedure in your company?</strong></td>
<td>Application of acknowledged integrity screening methods for employment of personnel enhances identification of future employees prone to unethical behaviour</td>
</tr>
<tr>
<td>Question</td>
<td>Description</td>
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| 39 Is there an ethical code of conduct or guideline in place and embedded in your company? | A transparent and specific ethical code of conduct or guidelines that is widely communicated and well embedded in management activities enhances prevention of unethical behaviour.  
  • No written code of ethical conduct or guideline exist  
  • General written code of ethical conduct or guidelines is available, but awareness amongst all personnel is limited, and or code is not explicitly embedded in management activities  
  • Detailed written code of ethical conduct or guideline is available and well embedded; awareness amongst all personnel is stimulated (e.g. posters, communication) and demonstrated in management activities |
| 40 Is there a whistle blowing system (system for reporting assumed fraudulent activities) in place in your company? | A well-designed and implemented whistle blowing system, including an independent officer and protection system for whistle blowing, enhances discovery of fraudulent activities.  
  • No whistle blowing system exists  
  • Whistle blowing system is available, but no clear protection system for the whistle blower is in place, and reporting of fraudulent activity goes to supervisor (no independent officer)  
  • Whistle blowing system is well-established and well-known among personnel, fraudulent practices can be reported to an independent officer, and anonymity of the whistle blower is strictly protected |
| 41 Do contractual requirements with your direct suppliers include elements that limit opportunities for fraud? | Established, comprehensive contractual requirements explicitly addressing fraud prevention enhance the prevention of fraudulent practices.  
  • Contractual requirements for direct suppliers are mainly set on logistic parameters: cost, amount and availability  
  • Contractual requirements are established together with direct supplier(s) for both logistic and safety & quality parameters  
  • Comprehensive contractual requirements established in close collaboration with direct supplier(s) addressing logistics, safety and quality, but also requirements on adoption of ethical code/guidelines, and adoption of similar technical fraud control measures |
| 42 What best describes the fraud control system of your direct supplier(s)? | Suppliers with well-designed and systematically audited Food Safety Management Systems that include dedicated fraud control measures enhances detectability of fraudulent products supplied to your company.  
  • Direct supplier(s) don’t have a FSMS or the FSMS is limited (not audited externally, no fraud measures in place)  
  • Direct supplier(s) has a well established FSMS in place that is regularly audited by a 3rd party and uses basic fraud screening methods  
  • Direct supplier(s) has a well established FSMS in place that is regularly audited by a 3rd party and systematically uses fraud screening methods and confirmatory tests to identify suspicious materials |

**NOTE:** As an alternative to answering this question yourself, direct suppliers can fill out the tool themselves with respect to the control measures.
<table>
<thead>
<tr>
<th><strong>as defined by the company</strong></th>
<th><strong>How extensive is the information system for control of mass balance flows of your direct supplier(s)?</strong></th>
<th><strong>How extensive is the traceability system of your direct supplier(s)?</strong></th>
<th><strong>NOTE: This question can be only asked directly of the supplier(s)</strong></th>
</tr>
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<tr>
<td><strong>43</strong></td>
<td>An advanced information system to control mass balance flows in the supplying company enhances discovery of problems in their mass balances and provide evidence of fraud control (assurance) to your company.</td>
<td>Suppliers with well-designed and audited traceability systems that systematically communicate accurate and fraud-relevant information to your company, enhances traceability of suspicious products/batches and limits damage in case of fraud.</td>
<td>NOTE: As an alternative to answering this question yourself, direct suppliers can fill out the tool themselves with respect to the tracking &amp; tracing system as defined by the company.</td>
</tr>
<tr>
<td></td>
<td>• A basic administrative system exists with limited/no specific information on mass balance flows of incoming materials and final products.</td>
<td>• Direct supplier(s) have a basic traceability system because of legal requirements but it not designed according to best practice nor audited by a 3rd party.</td>
<td>• Direct supplier(s) have a simple data capturing and retrieval system and there is no communication about deviations.</td>
</tr>
<tr>
<td></td>
<td>• A process monitoring information system exists with accurate information on mass balance flows of bulk ingredients only.</td>
<td>• Direct supplier(s) have a traceability system in place for safety issues that is based on a recognised standard and audited by a 3rd party.</td>
<td>• Direct supplier(s) have a simple digital data capturing and retrieval system, and information about suspicious materials is communicated ad hoc.</td>
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<td></td>
<td>• An established and comprehensive process monitoring information system exists dedicated to the control of mass balance flows (accurate mass balance data, of all crucial ingredients, materials, &amp; final product flows).</td>
<td>• Structured record keeping of mass data flow and systematic analysis of integral data across the company (including internal suppliers).</td>
<td>• Direct supplier(s) have advanced digital robust data capturing system; fraud proof.</td>
</tr>
<tr>
<td>45</td>
<td>How would you describe the social control and transparency of actions across your supply chain?</td>
<td>Extensive self-regulation and social control across the supply chain and transparent feedback/actions on criminal offences reduces opportunities and motives for potential offenders and enhances detectability of fraudulent behaviour</td>
<td>• No self-regulation and poor communication between companies across the supply chain</td>
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<td>• Limited/no self-regulating tools (e.g. code of conduct, certification scheme) exist, limited/no monitoring on compliance</td>
<td>• Self-regulating tools (e.g. code of conduct, certification scheme) exist but are not widely implemented and compliance is not monitored systematically</td>
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<td></td>
<td></td>
<td>• Unethical conduct is rarely communicated</td>
<td>• Only serious/obvious unethical conduct and/or incidents are communicated</td>
</tr>
<tr>
<td>46</td>
<td>How well established is guidance for fraud prevention and control across your sector of the food supply chain? (i.e. your company and your direct competitors)</td>
<td>Active communication of fraud incidents as well as guidelines, best practices and fraud monitoring and mitigation activates by companies supports the effectiveness of fraud monitoring systems</td>
<td>• No specific guidelines for fraud mitigation exist, or they are not shared; guidelines focus on safety only</td>
</tr>
<tr>
<td>47</td>
<td>How would you describe your national food policy? (i.e. country-level)</td>
<td>National food policy is the basis for legal controls. National food policy specifically addressing fraud and harmonised with internationally recognised recommendations enables systematic and consistent controls for food fraud mitigation</td>
<td>• Only a general national food policy exists without specific legislative requirements for food fraud mitigation</td>
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<td>How well are fraud prevention laws enforced locally?</td>
<td>National enforcement practices specifically aimed at food fraud and systematically supported by fines/sanctions helps to expand control measures and enhances fraud detection and prevention</td>
<td>No national fraud related enforcement practices exist</td>
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<td>How well are fraud related laws enforced across your international supply chain?</td>
<td>National enforcement practices aimed at food fraud aligned across links of the international supply chain, supported by fines/sanctions, increases the effectiveness of control measures and enhances fraud detection</td>
<td>Fraud related enforcement practices are lacking at most stages across the international supply chain</td>
</tr>
<tr>
<td></td>
<td>Does your company have fraud contingency measures in place?</td>
<td>An integrated risk/contingency plan for both fraud and food safety issues that is science-based, well documented and updated regularly can diminish the impact and consequences of fraud issues (internal or external)</td>
<td>No documented risk/contingency plan for fraud issues is in place</td>
</tr>
</tbody>
</table>