Agro-food Frauds: Legal and Normative Issues

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Paper prepared for presentation at the 6th AIEAA Conference
"Economics and Politics of Migration: Implications for Agriculture and Food"

15-16 June, 2017
Piacenza, Italy

Summary

The European Union has adopted a comprehensive strategy to prevent and fight agro-food frauds (AFFs).This strategy is based on many Regulations focusing in several aspects of AFFs. The most important are:- Regulation (EC) n.178/2002, setting up the general principles and requirements of a food law, establishing the European Food Authority (EFSA) and laying down procedures regarding matters of food safety. In addition, it has set up a regulatory system according to the principles of subsidiary principle and risk analysis. From this regulation, a set of EU regulations has emerged under the so-called the "hygiene package"; - Regulation (EU) No. 1169/2011, setting the rules for the provision of food information to consumers, harmonizing the various national laws and overcoming the requirements of the previous Directive 2000/13/EC; - Regulation (EU) no. 1151/2012 on quality schemes for agricultural products and foodstuffs produced with designation of origin, geographical indication or traditional speciality. This Regulation, known as "Quality Package". After a general overview, the main normative issue of two important sector are analysed: the wine and olive oil sectors. Both of them are regulated by several regulations, law and decree in order to coverage all the aspect of value chain to prevent and fight agro foods frauds.

Keywords: agro food frauds, regulations, law, value chain, wine, olive oil

JEL Classification codes: (Times New Roman 10)

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1. LAWS AND REGULATIONS TO FIGHT FRAUDS IN THE ITALIAN AGRO FOOD SECTOR

To protect the agro-food sector from frequent crises, the European Union, including Italy as a member State, has adopted a comprehensive strategy to combat and prevent agro food frauds (AFFs). Historically, Italian food law dates back to 1925 when the law no. 2033 was issued (and was converted into Law No. 562 in 1926). This law set up the general rules for the prevention of fraud in the preparation and trade in agro-food substances and products. In 1962, law no. 283 was issued allowing the investigation of fraud and food adulteration with the aim of protecting the public health. Forty years later, the integrated strategy of the EU regarding food safety has identified the same primary objective.

The initial assessments on this subject started in 1997 with the Commission's Green Paper on the general principles of food law in the EU. This led, in 2000, to the shared formulation of the White Paper on Food Safety. Both papers represented the will of policy makers to regulate this emerging problem, following numerous scandals of the eighties and nineties. In Italy, the scandal of the "methanol wine" in 1986 caused several deaths, leading consequently to the foundation in 1986 (by Law no. 462) of the Central Inspectorate for Quality Protection and Fraud Prevention (ICQRF). The ICQRF was established as official body of the Ministry of Agriculture (MIPAAF) to operate throughout the country aiming at combating fraud in the agro-food sector, playing an important role in protecting consumers and producers from unfair competition.

1.1. General legal framework

The actual formulation of the legislative and regulatory system governing the production, sale and consumption of food products began, however, with Regulation (EC) n. 178/2002 adopted by the European Parliament and Council. This Regulation has set up the general principles and requirements of a food law, establishing the European Food Safety Authority (EFSA) and laying down procedures regarding matters of food safety. In addition, it has set up a regulatory system according to the principles of subsidiary principle and risk analysis. From this regulation, a set of EU regulations has emerged under the so-called "hygiene package", which are namely the following EC regulations: no. 852, no. 853, no. 854 and no. 882, all issued in 2004. The latter, i.e. regulation no. 882, regards the official inspections that aim to verify compliance of feed and food products with the rules on the health and welfare of animals. Therefore, it is the standard framework for the organization of official inspections on food, feed, health and welfare whereas the inspection activities should be carried out periodically, based on a risk assessment with appropriate frequency to achieve the objectives defined in the regulation.

The same regulation also regulates the activities of the European institutions including the inspection in the Member States (art.45 through establishing the National Integrated Plan in Italy (PNI)), checking

against third countries (art.46), establishing protective measures (art.56) imposing import conditions (art.47), and providing training to achieve safer foods. The PNI, under chapter V of the regulation, describes the Italian system of official inspections on food, feed, animal health and welfare as well as on plant health issues. It aims at improving the effectiveness of official inspections by streamlining activities through an appropriate consideration of risks and proper coordination of all the institutions involved. The coordinating institution according to the PNI is the Ministry of Health that plans inspection activities through an intense collaboration with different bodies, including the ICQRF of the MIPAAF (particularly for food quality issues), the Ministry for the Environment, their departments in the Regions, as well as the Police and the Customs Department.

In 2008, following the preliminary consultation of stakeholders, the EC listed a proposal for a regulation on the provision of food information to consumers, from which the regulation (EU) No.1169/2011 was passed. This regulation regulates the provision of food information to consumers, harmonizing the various national laws and overcoming the requirements of the previous Directive 2000/13/EC, which needed to be updated in response to changing market dynamics and new information requirements for consumers. So the regulation aims on the one hand to adjust and standardize food products' labelling, presentation and advertising according to the food law (Reg. (EC) n. 178/2002), and on the other hand to be used as a general measure for application in the field of consumer information related to food products. The regulation applies to food business operators at all stages of the food chain where their activities concern the provision of food information to consumers. It applies, therefore, to all foods destined for the final consumer, including foods delivered by mass caterers and foods intended for supply to mass caterers. The regulation entered into force on 13 Dec. 2014, except for the provisions on the nutrition declaration on the label (Art. 9) which applied from 13 Dec. 2016.

At the national level, law no. 4 issued on Feb. 3rd, 2011, focused on details related to food labelling and food quality. The Italian Parliament intended with this law to guarantee that Italian consumers have complete and accurate information on the characteristics of commercialized food products, whether they are processed, partially processed or unprocessed. With this law, the indication of place of origin on food labels became mandatory on both unprocessed and processed food products. For the latter, the reported information must include the place (country) where the last substantial transformation took place as well as the place of primary production (i.e. farming) of the first dominant ingredient.

The process of strengthening European policy on food quality matters has further evolved with the passing (in Nov., 2012) of regulation (EU) no. 1151 (by the European Parliament and Council) on quality schemes for agricultural products and foodstuffs produced with designation of origin, geographical indication or traditional specialty. This regulation, known as "Quality Package", replaced regulation (EC) no. 509 and regulation (EC) No. 510 of 2006. This governs in a single text the Protected Denomination of Origin (PDO), the Protected Geographical Indication (PGI) and the Guaranteed Traditional Specialty (GTS), simplifies and strengthens the system of protection and makes it possible to use, together with signs of quality (PDO and PGI) of graphical representations, texts and symbols of the origins and geographical collective marks. Then a decree (no. 14 of 2013) of MIPAAF was added to the regulation regarding the provisions for the implementation and it was published in October, 2013, by the Official Gazette of the Italian Republic, which updates the procedures for registration and inspection regarding traditional products (Arfini, 2013).

1.2. Law enforcement framework

Enforcement of laws and regulations presented above is not possible without effective sanctions to deter the illegal actions. In Italy, the law on sanctioning administrative offenses is regulated by the legislative decree no. 297 issued in 2004. The decree regards penalty arrangements in application of regulation (EEC) no. 2081 of 1992 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs. In the various paragraphs of art. 2 of legislative decree 297/04, the legislature has guaranteed, alongside the administrative arrangements (which are the first bulwark to prevent offenses), the enforcement of criminal laws, giving space for simultaneous and combined implementation of administrative and penal sanctions.

To update the Italian legal system to the demands of criminal punishment for risk prevention in the context of certain corporate crimes, legislative decree 231/01 was issued. The decree regards the administrative liability of persons, companies and associations who does not perform functions of constitutional significance, allowing the assault of their assets and/or profits made with such offenses. These offenses cover the ones related to agribusiness particularly in the processing and marketing phases such as the sale of non-genuine foodstuffs as genuine, the sale of industrial products with misleading signs, manufacture and sale of goods made by illegal use of property rights, counterfeiting of geographical indications or origin of food products, and fraudulent trading.

In 2009, law no. 99/2009 (widely known as development law) has introduced severer criminal penalties including mandatory confiscation of goods and machines used in the crimes involving counterfeiting, altering or using trademarks, distinguishing marks, patents, models and design, and introduction into the country and sale of goods bearing counterfeit signs. In addition, it introduced two new types of crime designed to penalise the manufacture and sale of goods which infringe industrial property rights and the counterfeiting of Protected Geographical Indications or designations of origin for food products.

2. LAWS AND REGULATIONS TO PREVENT AND FIGHT FRAUDS IN THE WINE VALUE CHAIN

The regulations related to the wine sector are in constant changes to incorporate scientific innovations and the harmonization related to EU standards and international agreements on the production, trade, marketing and monitoring of wine products. In this regard, the general rules regarding food products are combined with specific rules on wine products that are by the EU, the national and regional Italian institutions.

The first rule to regulate food production and trade was law n. 283 of 1962, which laid down the hygiene regulations on production and trade of foodstuffs including beverages. The law has been subject to several modifications over time, with the implementation regulations approved by the Presidential Decree n. 327 of March 26, 1980. In 1986, as a result of many cases of food frauds on various foods (including wine containing methyl alcohol or toxic substances, the decree-law n. 282/1986 was issued (converted into law n. 462 in August of the same year). The law concerns urgent measures for the prevention and repression of the food sophistications. The law prohibits specifically the use of methyl alcohol, propyl, isopropyl in the production of foods and beverages, either alone or in mixture between each other. The law established also various methods and bodies to implement its obligations, among which was the creation, within the Ministry of Agriculture (MiPAAF), the Central Inspectorate for Quality Protection and Fraud Repression in Agro-

Food Products (ICQRF), with exercising functions relating to the prevention and prosecution of offenses in the preparation and trade of agro-food products including quality control at the borders.

2.1. General framework

By now, most national regulations on wine products, as all other food items, are based on EU legislations that established a European integrated strategy regarding food safety and quality. Specifically on wine, regulation (EC) n. 1493/1999 established the wine Common Market Organization (CMO), after which it became necessary to implement new measures align wine sector to the single CMO of all agricultural products, and this has been achieved mainly through regulations: (EC) n.1234/2007, (EC) n. 479/2008, and (EC) n. 491/20091.

In addition to prohibiting the vinification of all varieties of table grapes cataloged in the National Registry of vine varieties (sanctioned by Legislative Decree n.260/2000), they add the obligation on all member States to classify and demarcate the varieties of wine grapes. Furthermore, Annex I of regulation (EC) n. 479/2008 include the definitions of different typologies of wine products, incorporating everything that does not belong to the wine categories but still belong to the wine sub-sector such as wine fresh grapes, fresh musts, (concentrated) grape juice, different types of wine residues (e.g. wine lees) and others. On the other hand, the classification of different types of wine and must was provided by the same regulation (Annex IV) with corresponding definitions. Wines and musts are distinguished essentially on the basis of the actual alcoholic strength and the process of elaboration applied on the products at any given time. Accordingly, 17 different categories of wine and must are identified, whose characteristics may be further differentiated if we consider products with a designation of origin and geographical indication.

Regulation (EU) n. 1169/2011 provides the mandatory indications on the packaging and labeling of food products including precise indications on the readability of characters used. Specific on wine, regulation (EU) n.607/09 provides specific information including PDO and PGI wines, where it is indicated that the mandatory information relating to wine are presented in indelible characters and clearly distinguishable from all other information whether written or drawn without making any specific reference to the font size. This suggests that the two regulations (no. 1169/2011 and no. 607/09) complement each other where regulation 1169/2011 concerns the font size applies to all agribusiness products, including wine, while regulation 607/2009 establishes additional information to distinguish the information on the specific wine from the rest of the other indications.

2.2. Quality standards for wine products

Quality standards for wine have been regulated by several rules. Regulation (EC) n. 436/2009, which was one of the implementation regulations related to regulation (EC) n. 491/2009, specifically on PDO and PGI wine products with their related labelling and marketing issues. Organic wine, on the other hand, is regulated by regulation (EU) n. 203/2012 (which amended regulation (EC) n. 889/2008) laying down

[1] The modality of implementation of these regulations were established by other 4 regulations: reg. (EC) n. 555/2008 (support programs, trade with third countries, production potential and controls in the wine sector); reg. (EC) n. 436/2009 (protected designations of origin and protected geographical indications, traditional terms, labelling and presentation of certain wine sector products; reg. (EC) n. 606/2009 (categories of grapevine products, oenological practices and restrictions); and reg. (EC) n. 607/2009 (vineyard register, compulsory declarations and information for control of the market, the documents accompanying the transport of the products and records kept in the wine sector).

detailed rules for implementing regulation (EC) no 834/2007 concerning the manner of its application to organic wine. In fact, before 2008, vinification was excluded from the regulation, where the final product was labelled as "wine obtained from organic grapes" affirming that the certification would stop at the production of grapes.

Since 2008, however, organic wine has been regulated by specific rules their most recent details laid down in regulation (EU) n. 203/2012, while "wine obtained from organic grapes" is now regulated simply according to the wine CMO, already established by regulation (EC) n. 1493/1999. So this latter wine is considered a conventional wine for all aspects except for the raw material which is obtained from organic agriculture. Organic wine, on the other hand, requires other elements regarding the enrichment, the content of sulfur dioxide, the positive and/or negative list of techniques used for winemaking, types of additives permitted/prohibited in the vinification, etc. In brief, organic wine is a product of a series of certified processes/materials from the production of grapes to the bottling and labelling of wine.

Aromatized wine products, which are products derived from wine (but they may not be wines) and are later aromatized. They are classified into the following categories: (1) aromatized wines; based aromatized drinks wine; and aromatized wine-product cocktails as stated in regulation (EU) n. 251/2014 (which replaced totally regulation (EEC) n. 1601/91) that states their definition, description, presentation, labelling and protection of their geographical indications, in addition to determining the conditions of their production and trade inside and the EU and abroad.

2.3. Enforcement issues

In Italy, law n. 82/2006, on measures for the implementation of EU legislation concerning the CMO for wine, is the main reference point of national legislation and regulation regarding the safeguarding of wine value chain (VC). The law has been followed by a series of ministerial decrees from the Italian Ministry of Agriculture (MIPAAF). It regulates, in addition to the native Italian vine varieties, the production of musts and wines including, sparkling wines as well as banned substances and other provisions. The law also regulates the penalties regarding breaching and frauds that violate the rules of production and marketing of musts, wines and vinegars. It defines the allowed substances that can be used in wine and must production, in addition to the rules that govern the access of inspectors to appropriate data and information to achieve suitable surveillance. Moreover, the law introduces the sanctions in case unauthorized items/methods are used whether in production, marketing or distribution including the transportation.

The implementation measures regarding designations of origin and geographical indications for wine products are regulated by Legislative Decree n. 61/2010, that was issued based on article 15 of Law n. 88/2009 regarding the necessary national measures to comply with the obligations born from the membership of Italy in the EU. Decree n.61/2010 aims mainly at improving the protection for consumers and simplifying the relevant bureaucratic apparatus. The latter is achieved by redefining the role of the National Committee for the protection and promotion of designations of origin and typical geographical indications for wines. The decree thus unified all quality products that have designation of origin into two major categories. The first is the group of the PDO (protected designation of origin) products, which will continue to include the CDO (controlled designation of origin) and GCDO (guaranteed and controlled designation of origin). The second is the category of PGI (protected geographical indication) which also includes TGI (typical geographical indication). Another important element imposed by Decree n. 61/2010 was the establishment of the PDO and PGI National Committee, a body belonging to MIPAAF to support it with

consultancy on how to protect and enhance DOP and IGP wine products. The decree also includes a chapter detailing the sanctions of irregularities relevant to DOP and IGP wine products, while the measures and information related to the inspection activities are detailed in Decree of MiPAAF.

In addition, and due to overlapping of competences between the ICQRF and the former Technical Committee for inspection in the wine sector (both date back to the eighties), Decree n. 6634/2014 approves the transfer of the functions provided by regulation. (EC) n. 555/2008, already carried out by the Technical Committee, to the ICQRF. These functions are mainly related to the cooperation between the major inspection bodies in the member States.

3. LAWS AND REGULATIONS TO PREVENT AND FIGHT FRAUDS IN THE OLIVE OIL VALUE CHAIN

Historically, national Italian food law dates back to 1925 when the law no. 2033 that was issued (and was converted into Law No. 562 in 1926). However, this was preceded by law no. 1407/1960 that was the first to regulate the classification and sale of olive oils, and then followed by law no. 1104/1962 that prohibited the esterification of any kind of oils destined for edible use. Later, in 1968 and in order to prevent frauds in the olive oil sub-sector, law no. 35/1968 was issued to regulate standards for advertising and trade in olive oil trade and oil seeds.

3.1. Quality and marketing standards in olive oil products

Regulation (EEC) no. 2568/1991 and subsequent updates[2] have already set the minimum quality standards that olive oil must demonstrate in order to be marketed under the label virgin or extra-virgin. These regulations particularly defined the physical, chemical and organoleptic characteristics of oils to ensure product quality. They also established that the verification of compliance to organoleptic characteristics is carried out by specialized tasting panels approved by the relevant Member State. However, regulation (EU) no. 29/2012 opened a new chapter on the rules governing the marketing of olive oil, confirming all previous settings contained in the marketing standards for olive oil but harmonizes them. This includes the requirement to clearly indicate the origin of the product[3], the acidity, the peroxides and the ultraviolet refraction, method of pressing (e.g. cold pressing), the sensory aspects (e.g. fruity, spicy, bitter, etc.). To increase consumer protection, the regulation confirms what was stated in regulation (EU) no. 1169/2011 (refer to the previous section/2.2) concerning the indication on the label of the type of vegetable oils used in the production of canned food (e.g. rapeseed oil, palm oil, etc.) especially for the products that traditionally canned with extra virgin olive oil. On the other hand, regulation (EC) n. 1019/2002 and subsequent amendments[4] established specific standards for retail-stage marketing of particular olive oils and olive-pomace oils, with particular concerns on packaging and labelling.

The major quality standards of olive oil adopted by the EU, and thus Italy, are stated in regulation (EU) no. 1308/2013, which defines the virgin olive oil as the one obtained solely from olive fruits by mechanical or other physical means under conditions that do not cause deterioration of the oil, and which have not undergone any treatment other than washing, decantation, centrifugation, or filtration. This excludes

[2]Reg. (EEC) n. 2568/1991 has been amended several times since its issue. The most recent amendments were carried out by regulations no. 1830/2015, 1348/2013 and 299/2013.
[3]This means that all information related to the geographical area where olives were harvested and where they were milled must be mentioned.
[4] This regulation has been amended by Regulations (EC) no. 1964/2002, no. 1176/2003, no. 406/2004, no. 1750/2004, no. 1044/2006, no. 632/2008, no. 1183/2008, and no. 182/2009.

from the virgin olive oils, the ones obtained using solvents, adjuvants and any other chemical or biochemical materials including any re-esterification processes or any mixture with oils of other kind. Therefore, virgin olive oils can be classified in three main groups: (1) extra virgin olive oil whose acidity is no more than 0.8%; (2) virgin olive oil whose acidity lies in the range 0.8-2%; and (3) raw olive oil whose acidity is higher than 2%.

3.2. Enforcement mechanisms

The Ministerial Decree no. 8077/2009 regulates the implementation and the enforcement of the rules relating to regulation (EC) no. 182/2009 and its amendments related to the marketing rules for olive oil, with particular reference to the rules of the designation. It also states the manner of labelling and packaging, for edible olive oils and olive-pomace oils destined to the final consumer, in addition to the preparation of meals among other things.

The Decree no. 8077/2009 was later integrated with the Decree no. 16059/2013 regarding the national procedures related to the implementation and enforcement of regulation (EEC) no. 2568/91 and its amendments on the characteristics of olive oils and olive-pomace oils and on the relevant methods of analysis as it was necessary to incorporate the new EU provisions. Following the issuance of the two decrees and the subsequent simplification statements filed by the olive oil value chain achieved by registering the olive oils on the National Agricultural Information System (SIAN), it became necessary to extend the obligations to all agents involved in the olive oil value chain, from farmers to retailers. This aims at achieving a complete product traceability that will enable better inspection and more efficient monitoring and it was enforced by Decree no. 4075/2015.

Concerning sanctions to enforce regulation (EC) no. 1019/2002 in Italy on the marketing of olive oil, the Legislative Decree. no. 225/2005 was issued determining the fines for different types of frauds. This including among others lack of conformity in pre-packaging and misleading labelling including uncertified designation of origin, while the verification of conformity was assigned to the ICQRF thanks to the Decree of 29 April 2004.

In addition, law no. 134/2012 was issued in order to prevent frauds in the olive oils labelled with the words "Italy" or "Italian". The law states that these oils are considered in compliance with the declared category only when the contents of methyl esters and ethyl esters of fatty acids are less than 30 mg/kg. This was followed by law no. 9/2013 on the regulations on the quality and transparency of the virgin olive oil supply chain (or the so-called "save oil" Law), which assumes great importance in the wider context of the EU food information regulation (reg. (EU) no. 1169/2011). This law imposed a set of procedures that must be pursued on the oil packaging and labelling. Among others, the readability of the indication of origin and the clear indication of oil mixes are the most important.

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Agro-food frauds in Italy: Where, When and How

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Paper prepared for presentation at the 6th AIEAA Conference
"Economics and Politics of Migration: Implications for Agriculture and Food"

15-16 June, 2017
Piacenza, Italy

Summary

The paper is based on an introductory analysis of agro-food frauds in Italy and aims to get some preliminary insights for the improvement of food fraud monitoring system. To pursue this objective, we used explorative statistical methods analysing the phenomena over time, geographically and at the value chain level. The analysis shows that the ICQRF may consider a reallocation of the inspection resources from smaller regions (generally featuring with low intensities of irregularity) to larger ones (with higher intensities of irregularity) to improve the inspection efficiency.
The analysis at value chain level shows that wine and olive oil are the food subsectors with highest intensity of irregularities. In the wine value chain, most irregularities (95%) are put in place by only three agents (individual cellars, bottlers-wholesalers and retailers), who are also responsible for more than 99% of the total seizures value. Thus, monitoring activities should focus more on individual cellars especially those who extend their activities over other value chain phases such as bottling and distribution. More attention should be also paid to high quality wines (DOP and IGT) especially the ones oriented to exports, which present higher opportunities for frauds taking advantage of the Italian sounding.
For olive oil value chain, the reallocation of ICQRF resources should be primarily considering the most critical points where more than 95% of the seized olive oil in terms of value occurred in only four phases: integrated firms (32%), wholesalers (27%), services providers (26%) and bottlers (10%). In particular, integrated firms should have priority in inspections since the highest proportions of irregularities and highest values of seizures occur within these firms. Other important agents of the value chain that require more attention are millers, while retailers, farmers and HO.RE.CA result to be less risky.

Keywords: food fraud, ICQRF, intensity of irregularity, wine value chain, olive oil value chain.

1. INTRODUCTION

Evidence on food fraud has been found since the old ages. However, the scale of food frauds is now rapidly growing because modern food supply chains have been lengthened and complicated, expanding their scale and compounding the difficulty in detecting frauds (as well as their potentially negative impacts). The problem is exacerbated by the complexity and the high levels of sophistication of many agro-food production processes that make more difficult the chance to spot counterfeiting activities. This is why the agro-food sector ranks as third among sectors most affected by counterfeiting, clothing & accessories and audio-visual CD & DVD, respectively (Censis, 2012).

The importance of studying the counterfeiting and frauds in the food sector emerges from its apparent vulnerability to fraudulent behaviour for several reasons, which individually or collectively shed light on one or more of the of fraud triangle corners. The expansion of global markets causes the fraud risks to increase as companies have less control over production process and thus are less accountable for many essential processes along the supply chain.

Dire economic conditions, such as adverse price changes and shortages if some ingredients, play also their role in fostering frauds. This encourages operators who are squeezed by higher costs to surrender to the opportunity temptation. Technological progress, which may play its role in combatting and containing such illegal activities, can in turn be used to enhance them. The rise of internet power as a retail channel for consumer products has added another complication to the scene especially that such channel is much more difficult to control and monitor. In addition, perpetrators are becoming more and more sophisticated in committing frauds taking advantage of the technological progress.

Considerable attention has been recently given to food frauds in Italy and at the EU level. In Italy, there is room for improving the effectiveness of inspection activities. For instance, only recently there have been attempts to build a unified data information system on inspection activities that could help to better understand and monitor this phenomenon. There are indeed many bodies and agencies involved in these activities and each one has built his own data management system. Among those bodies, the ICQRF (Central Inspectorate for Quality Protection and Fraud Prevention) of the Italian Ministry of Agriculture (MIPAAF) is the only Italian inspection body that is specialized in the repression of agro-food frauds and in monitoring regulatory interventions. The ICQRF has an inspection system spanning over the whole country, with inspection activities performed in all value chains (VCs) of the agro-food sector from agricultural production through processing and distribution to retailing.

This study is based on ICQRF's monitoring activities database to carry out a descriptive analysis of frauds in the Italian agro-food sector. This is the overall objective of this paper, which will be pursued through two major paths using explorative statistical analysis: (1) analysing the evolution of the phenomenon over the period 2007-2015 by type of fraud and product characteristics, and (2) providing disaggregated analysis of the phenomenon by geographical location and by value chain. In doing this we hope to be able to shed some light on how to improve the ICQRF's monitoring system.

Given the above, the paper is organized as follows. Section 2 introduces the concepts of food fraud and counterfeiting. Section 3 aims at describes the data sources as well as data handling for the analysis carried out in this study. Section 4 presents some recent trends of frauds and counterfeiting in the whole

Italian agro-food sector, disaggregating the analysis by geographical location and by value chain. Section 5 provides and in-depth highlights on frauds in the most important food value chains in Italy; namely wine and olive oil. A concluding section provides an assessment of the major research findings, with a discussion on policy implications as well as suggestions for further research.

2. THE CONCEPT OF FRAUD AND GENERAL DEFINITION

The definition of food fraud differs between different authors, countries and contexts. In this paper we adopt the definition of food frauds proposed by Spink and Moyer (2011) according to whom "food fraud is any intentional act that encompasses the substitution, addition, tampering, or misrepresentation of foods, food ingredients, or/and food packaging; or false and/or misleading statements made for a product for the purpose of illegal economic gain." Therefore, a food fraud is an intentional illegal act made for sake of economic gain. This definition focuses on the legal aspect of the action that is "intentional", i.e. it is done looking for economic gain, and may or may not cause a harm. The authors, in their classification of food risks (Tables 1 and 2), clearly distinguish food fraud issues from other concepts connected to food safety incidents (unintentional acts that result in harmful health consequences) and food defence issues (intentional acts with harmful health consequences). They emphasize the intentional economic motivation as the basis for a food fraud, which distinguishes it from the concept of food quality when the act is unintentional with no health implications although an economic gain is achieved.

Table 1. Food protection risk matrix.

Motivation / (Actions)	(Unintentional)	(Intentional)
Gain: economic	**Food quality**	**Food fraud***
Harm: public health, economic, terror	**Food safety**	**Food defence**

Source: Spink and Moyer (2011: Figure 2).
* This includes all the subsets of economically motivated adulteration and food counterfeiting.

Table 2. Risk cause and effects for the food disciplines.

Discipline risk type	Example	Cause and motivation	Effect	Public health risk type
Food quality	**Accidental** bruising of fruit	Mishandling	Unsalable product or possible additional contamination with E. coli O157:H7	None or Food Safety
Food fraud	**Intentional** adulteration of milk with melamine	Increased margin	Toxic poisonings	Food Safety
Food safety	**Unintentional** contamination of raw vegetables with E. coli O157:H7	Limited field protection and control during harvesting and processing	Illnesses and/or deaths	Food Safety
Food defence	**Intentional** contamination of ground beef with nicotine	Revenge intent against the store/manager through injury to consumers	Nonlethal poisonings	Food Defence

Source: Spink and Moyer, 2011 (Table 2).

Given the above, food fraud as a collective term encompasses the deliberate and intentional substitution, addition, tampering, or misrepresentation of foods, food ingredients, or/and food packaging; or false or/and misleading statements made for a product, for the purpose of unauthorized economic gain (Table 3). Whether the fraud occurs through adulteration or misbranding, it creates high potentials for the occurrence of public health incidents. Therefore, although the motivation is economic, the consequence might probably be a serious public health risk, where in in some ways, food fraud threats are considered

riskier than conventional food safety threats since the contaminants may be unknown (Spink and Moyer, 2011).

Table 3. A taxonomy of food frauds

Type	Definition	Example
Adulteration	A component of the finished product is fraudulent	Melamine added to milk
Tampering	Legitimate product and packaging are used in a fraudulent way	Changed expiry information, product up-labelling, and so on
Over-run	Legitimate product is made in excess of the production agreements	Under-reporting of production
Theft	Legitimate product is stolen and passed off as legitimately procured	Stolen products are co-mingled with legitimate products
Diversion	The sale or distribution of legitimate products outside of intended markets	Relief food redirected to markets where aid is not required
Simulation	Illegitimate product is designed to look like but not exactly copy of the legitimate products	"knock-offs" of popular foods not produced with same food safety assurances
Counterfeiting	All aspects of the fraudulent product and packaging are fully replicated	Copies of popular foods not produced with same food safety assurances

Source: Spink and Moyer (2011: Table 4).

This definition of fraud allows its decomposition into two broad groups, namely: physical modification and misrepresentation of the product. This goes in line with the definition of consumer food fraud provided by GMA & A.T. Kearney (2010) that refers to the two aspects of adulteration and counterfeiting. The former is defined as the intentional modification of the finished product or one of its ingredients for economic gain though unapproved enhancement, dilution with lesser value ingredient, concealment of damage or contamination, mislabelling of the product, substitution of a lesser-value ingredient or failing to disclose the necessary information on the product. On the other hand, counterfeiting refers to the unauthorized representation of a registered trademark carried on goods similar to goods for which the trademark is registered, with the intention of deceiving the purchaser into believing that he/she is buying the original good.

Therefore, in this paper, a food fraud implies one or more of the following: alteration, adulteration, sophistication, and falsification of agro-food products as well as counterfeiting, that is the falsification of their trademarks including those related to the indication of geographical origin. Operationally, with specific reference to the ICQRF database as we see below in section 3, a food fraud exists whenever the inspected product features any kind of irregularity no matter if it is of administrative or criminal nature, not matters whether it leads to the confiscation of the product or to other administrative penalties such as fines and warnings.

3. DATA AND METHODS

3.1. Data sources

In Italy, there are several bodies and agencies involved in fighting food frauds, including counterfeiting. Two of them are specialized agencies of the ministry of Economy, namely the Tax Police (Guardia di Finanzia) and the Custom Agency (Agenzia delle Dogane). There are also other bodies such as the National Police (Polizia dello Stato), the Local Police (Polizie Municipali), the Carabinieri. The Ministry of Agriculture, through the ICQRF, is the only organization operating at national level with a specific focus on the fight against fraud in the food sector (Riccio et al., 2014).

There is no clearcutting allocation of competencies among these agencies/bodies. Except for the Custom Agency, whose mandate is concentrated on border controls, all the others can make inspection to fight frauds on the national territory. Therefore, to have a comprehensive picture, data from each of those agencies/bodies must be collected and analysed. This is what has been done over the last few years under the supervision of Directorate-General for the Fight against Counterfeiting of the Ministry of Economic Development, creating the so-called Intellectual Property-Elaborated Report of the Investigation on Counterfeiting (IPERICO) database. The purpose of IPERICO is to collect and harmonize data on the seizures made by all bodies/agencies (Riccio et al., 2014)..

Therefore, there is a potential to construct a unique dataset that can gather all relevant data on the phenomenon, collected by various bodies allowing a comprehensive analysis without the risk of double counting. However, such an objective can be only achieved through accessing the original datasets of the various inspection agencies, whose data are summarized the IPERICO project. In fact, only ICQRF dataset has been provided at the micro level while data of the other agencies have been obtained in summarises, and sometimes with varying degrees of details and disaggregation on temporal level as well as value chain level. For example, IPERICO does not include data other than seizures while the ICQRF provided an enormous database that is not limited to seizures but includes also detailed information on all inspected products and agents that are classified in terms of their subsectors and geographical locations.

Given the above, we rely in this paper exclusively on the ICQRF data, which includes detailed information on the inspection activities that are conducted systematically in all agro-food subsectors along the entire value chains from the producers/processors to the retailers. As the ICQRF system of records keep records not only of all types of frauds but also of the inspections that result in legal consequences for the inspected agents and their products, we believe that they are sufficiently good to provide an introductory analysis of the phenomenon, the major objective of this paper. Data from other sources are also used to construct the value chains used for the in-depth analysis of frauds in the wine and olive oils sub-sectors. The other data sources are Malorgio et al. (2011), Mazzarino and Corsi (2014), and ISMEA (2015) for wine value chain, while for olive oil value chain we used data from ISMEA (2014).

3.2. ICQRF data description and elaborations

The ICQFR activities can be categorized in two major types: inspections and reports. Inspections are the initial activities conducted by the ICQRF, while reporting is a possible consequence of inspections. We say possible because not all inspections are actually reported, while the latter is mandatory only if something irregular is detected. However, since a minimum number of reports is requested by every inspector regardless of irregularities, the total number of reports is larger than the number of detected irregularities, the latter being the ICQRF term used to describe what we defined as an agro-AFF in section 2.2.

Inspections and reports refer to two subjects: agents and products. Every inspection and report is identified through a unique ID code and is associated to only one agent, while it can be associated to more than one product. In other words, under each inspection and report, there is only one agent, but there might be more than one product. However, some agents might be inspected and reported more than once, which means that agents can be associated with more than one inspection and report.

The ICQRF monitoring activities are assembled in an enormous database that systematically records all ICQRF inspection activities disaggregated per geographic and at sub-sector level. This database includes all ICQRF inspection activities in the agro-food sector in Italy over the period 2007-2015. The data were

provided by ICQRF as five separate datasets as follows: inspected products, inspected agents, reported products, reported agents and seizures.

1- *Inspected products* contains detailed information on each product identifying its typology, its position in the value chain, its quality characteristics, the type of inspection, the inspection date and the number of products under each inspection.

2- *Inspected agents* includes agents location (province and region), the main economic activities conducted (production, transformation, trade), and the subsector of the inspected products. In addition, two codes are provided to uniquely identify the inspected agent and the associated establishment unit respectively. The latter is a subset of the former in the sense that any agent must be associated with at least one establishment, but in many cases, one agent could have more than one establishment. The data in this file are linked to the data of the inspected products dataset through the inspection ID, which is unique for each inspection.

3- *Reported products* contains information only on the products that have been "reported". The activity of reporting is not performed for all inspected products and in regular cases, it is up to the inspector to decide whether to report or not. However, whenever the inspector finds an irregularity, a report must be written. As in the case of inspections, a report includes data on one or more products, since each report is associated with an inspection. Every report is identified through an ID code that is unique for each report. In addition, the inspection ID is also reported in this dataset to link each report to its associated inspection in the inspected products dataset. The information included on each reported product identifies the product typology, its position in the value chain, its quality characteristics, the report type, the report date, and the product status, i.e. whether it is regular or not.

4- *Reported agents* contains the same information as the inspected agents' file but focusing only on the reported agents, i.e. those agents whose products have been reported as explained right above. In addition, the dataset includes four IDs: the inspection ID, the report ID, the agent ID as well as the establishment ID. One more thing to notice here is that, under the same inspection, the reported agent in some cases might be different from the reported one. This may happen because when an irregularity is found the report is written about the agent responsible for the irregularity who may not be the inspected one.

5- *Seizures* consists of detailed information on the seizures conducted by the ICQRF including the product typology, its quality characteristics and the quantity and value of the seized product as well as the region and provinces in which the product was seized and produced. These data are linked to the data on reported products, through the report ID, meaning that a seizure is one reason for reporting.

The only bridges across files are specific codes assigned to inspections, reports, agents, and establishments, which represent a unique ID for each inspection, report, agent or establishment. The database is huge whereas the file of inspected products includes more than 590 thousands records and other files include more than 358 thousands (reported products), 339 thousands (inspected agents), 271 thousands (reported agents) and 6.4 thousands (seizures) records.

An initial data cleaning was conducted aiming to understand the structure of the data and to discover problems or/and inconsistencies. Then the data were all transformed into Microsoft Access format to find a way of linking the five files together in order to have a single record connecting all data relating to one

inspected (and eventually reported) product, inspected (and eventually reported) agent, and the relevant seizures. The objective was to have one single database including all the data, allowing a unified analysis of the data by value chain level, date, region, and economic activity, without losing information while avoiding repetitions.

This task has not been performed completely. It was easy to link inspected and reported products to inspected and reported agents respectively, through the ID codes. But when we tried to link inspections to reports, the resulting file was inflated. This is because there is not one unique code in all datasets that identify any inspected product and links to it to its reported status. The only database IDs are only inspections and reports which may include more than one product. Due to this reason, we abandoned organizing all the data in only one dataset, and preferred to seek other *ad hoc* solutions that enable us to perform the required analysis. We ended up with three datasets: inspections (products and agents) with about 490 thousands observations, reports (products and agents) with more than 295 thousands observations, from which about 5.1 thousands are reports of seizures.

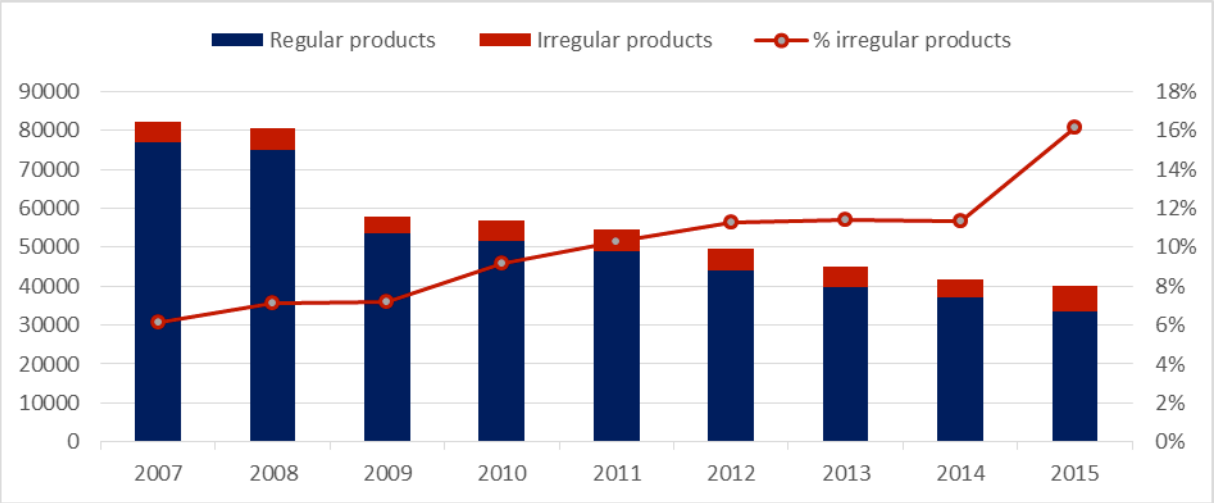
The products in the ICQRF original dataset are classified according to VCs through a code. However, the level of aggregation/disaggregation, which is suitable for the ICQRF inspection activities, is not convenient for our analysis. Therefore, we had to reclassify the products using as a reference the definition of agro-food sub-sectors applied by the Institute for Services to Agro-Food Markets (Istituto di Servizi per il Mercato Agricolo Alimentare - ISMEA). This is because we use the same classification for disaggregating the SAM model that will be used for assessing the impact of frauds on the Italian economy. The resulting sub-sectors are the following:

1- Production, manufacturing and conservation of meat,
2- Manufacturing of fish and fish products that are transformed and conserved,
3- Production of olive oil, refined and unrefined,
4- Production of other food products (vegetal oils, sugar, pasta and farinaceous products),
5- Manufacturing of fruits and vegetables that are transformed and/or conserved, including fruit juices,
6- Hygienic treatment of milk and production of its derivatives
7- Manufacturing of cereals and production of starch products including rice milling,
8- Production of feed and fodder for animals
9- Production of wine
10- Industry of mineral water, non-alcoholic drinks and other alcoholic drinks.

4. RECENT TRENDS OF FOOD FRAUDS IN ITALY: DISAGGREGATION BY REGION AND BY VALUE CHAIN

ICQRF data (Figure 1) shows that the share of irregular products relative to all inspected products has been steadily increasing, with a noticeable jump starting from 2009 probably due to the crisis, which created economic pressure motivating more fraudulent behaviour. From 2012, the pace becomes somehow stable until 2015 where the ratio jumped from 11% to 16%. Over the whole period, the ratio increased by about 10 percentage points (from 6% to 16%). This can be an indication of increasing fraudulent activities, but it can be an indication of improved efficiency of the inspection activities gained from past experience.

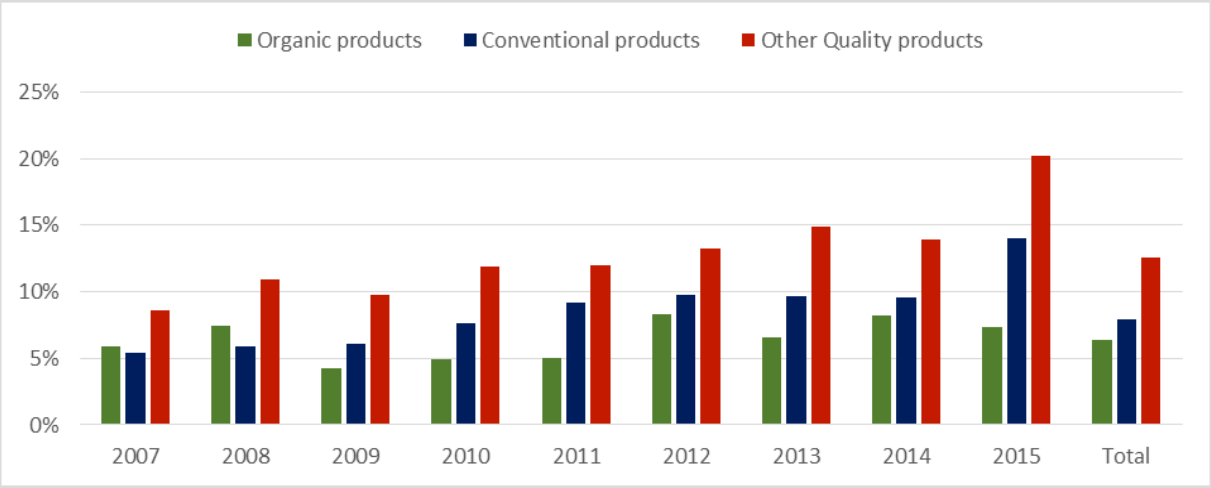
Figure 1. Products: inspected, irregular and proportions



Source: authors' elaboration on ICQRF data.

Analysing the relationship between irregular and inspected products by their quality characteristics reveals some interesting findings. Non-organic quality products such as DOP, DOC, DOCG, etc., show a higher likelihood of being irregular than the conventional or organic products (Figure 2). This probably depends on the expected higher payoff of frauds in such categories than conventional and organic products. This explains, at least partly, the increased shares of these products in the inspections based on the ICQRF evaluation of past results.

Figure 2. Proportions of irregular products by quality characteristics

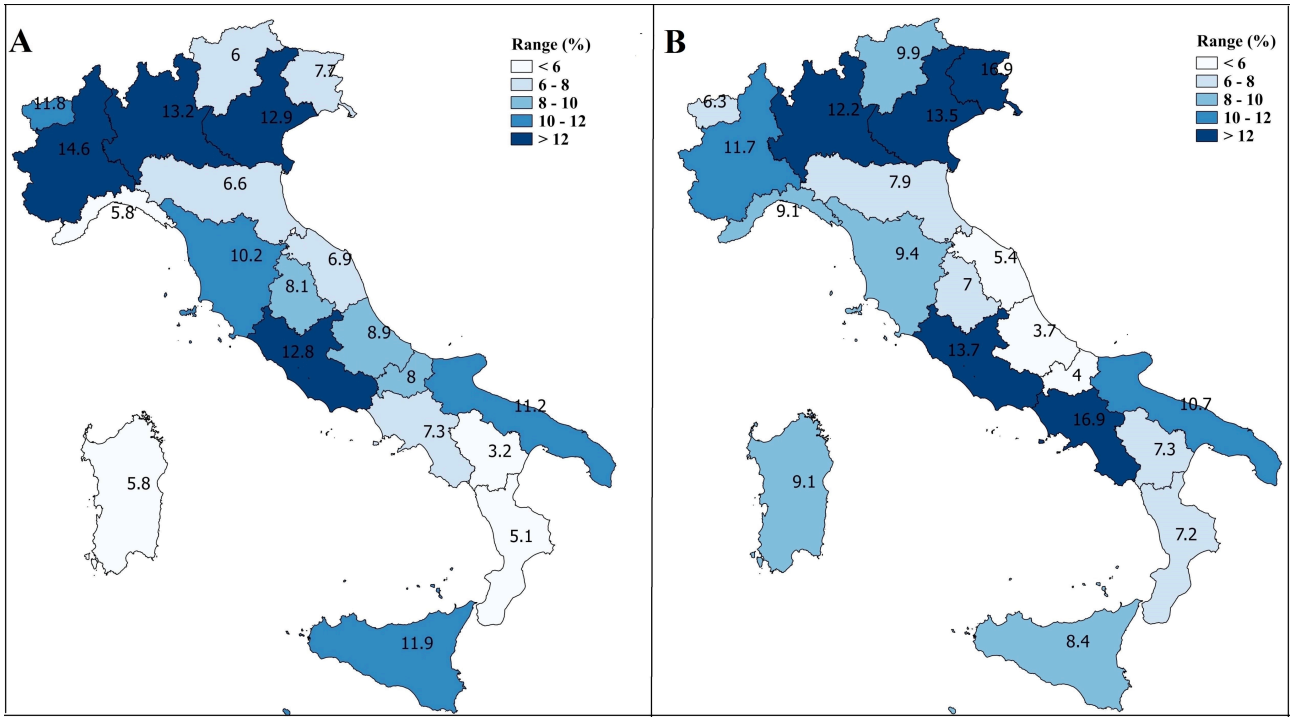


Source: authors' elaboration on ICQRF data.

4.1. What are the regions with highest intensity of frauds?

To get some insights on the intensity of irregularities we look at the proportion of irregular products vs. inspected ones as well as the proportion of seized products (as seizures are the strongest sanctions imposed by the ICQRF) to irregular ones. These two proportions are presented in Figure 6.3 A and B, respectively.

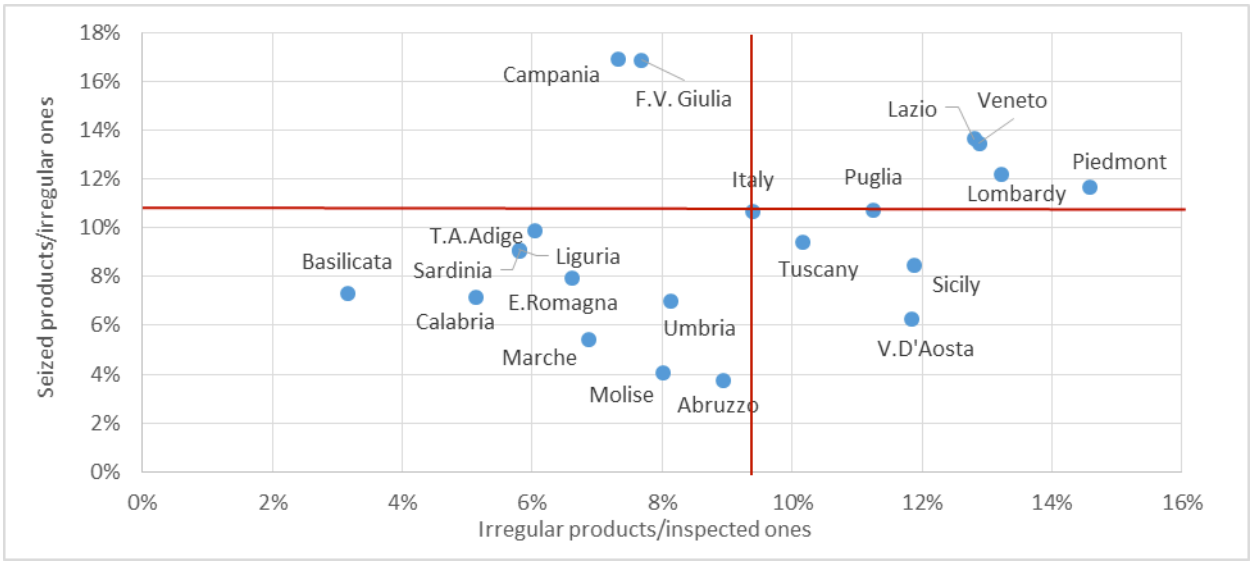
Figure 3. Proportions of irregular products to inspected ones (A) and seized products to irregular ones (B) by region



Source: authors' elaboration on ICQRF data.

The regions showing the highest proportions of irregular products/inspected ones are largely the same that have the highest proportions of seized products/irregular ones, namely Lazio, Lombardy and Veneto and, to a lesser extent, Piedmont and Tuscany. However, some other regions show considerable differences in the two proportions such as Campania and Sardinia, with much higher proportion of seizures compared to that of irregularities. Small regions like Molise and Abruzzo, on the other hand, have the proportion of irregularities noticeably higher than that of seizures.

Figure 4. Proportions of irregular products to inspected ones vs proportions of seized products to irregular ones by region



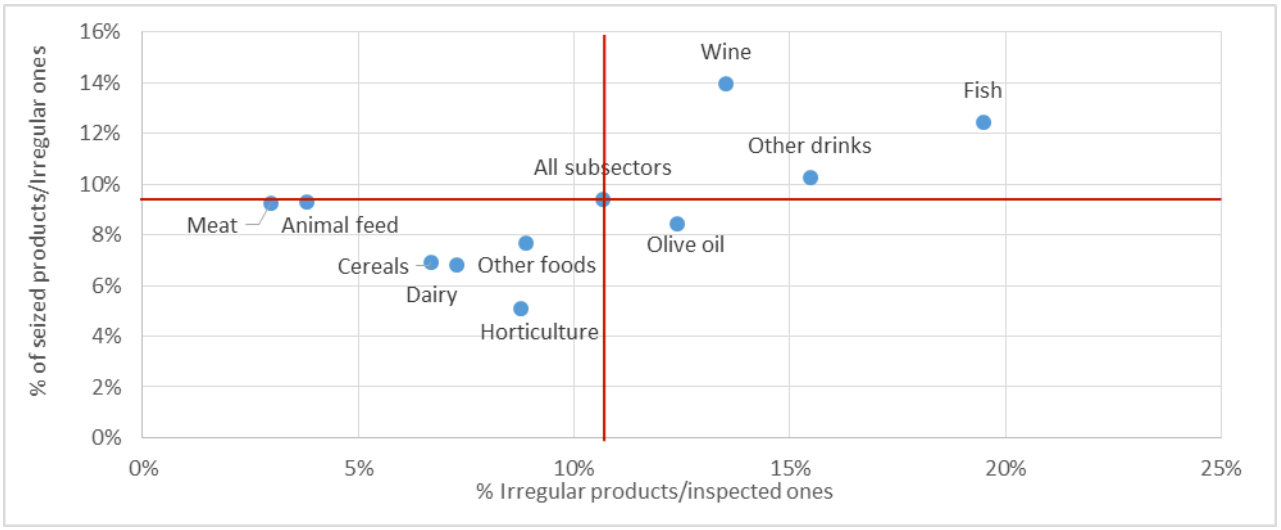
Source: authors' elaboration on ICQRF data.

Figure 4 plots the two ratios against each other with the red axis representing the national averages. Veneto, Lazio, Piedmont, Lombardy and Puglia are the regions where both proportions are higher than the national averages. On the other hand, Campania and Friuli V.G. show proportionately more seizures than irregularities, while the opposite is true for Sicily, Tuscany and Val d'Aosta. Most of the other regions, however, have both proportions lower than the national averages. Therefore, the figure shows that relying on numbers of irregular and seized products, frauds are more intense in Veneto, Lazio, Piedmont, Lombardy, and Puglia, followed by Sicily, Tuscany, Campania and Friuli V.G.

4.2. Wine and olive oil value chains are the hotspots

Analysis of ICQRF database reveals that wine and olive oil are the two value chains most affected by food frauds. This finding was reached by first looking at the intensity of irregularity by subsector, defined as relationships between seizures, irregularities and inspections for products. By comparing the proportion of seizures to numbers of irregular products and the proportion of irregular products/inspected ones as shown in Figure 5, we see that the intensity of irregularity is higher than the averages for wine, fish and other drinks. Olive oil is the only subsector whose intensity is higher than average in terms for the number of irregular products but lower than the average for the number if seizures. All the other subsectors show an intensity of irregularities lower than the average.

Figure 5. Proportions of irregular products to inspected ones vs proportions of seized products to irregular ones by VC



Source: authors' elaboration on ICQRF data.

However, as the number of seizures does not reflect the value of seized products. We complements the previous findings by looking at the values of seized products by subsector as shown in Table 4. We see that wine shows by far the highest value, followed by olive oil: these two subsectors account for more than 90% of total seizure value over the period of 2007-2015, and the observation is largely valid for each year too. The data show an extreme value for wine in 2008, which makes by itself 48% of the value of all seized products over the entire period of 2007-2015 and 98% of the value of seized products in 2008. This extreme value is probably due to the so-called "Velenitaly" scandal when numerous violations in several regions were detected (Wikipedia, 2016).

Table 4. Values of seizures implemented by ICQRF by year and subsector (thousands of euro)

Subsector	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total

Meat	14	10	57	71	10	160	4	3	18	346
Fish	86	0	9	1	48	34	1	4	5	187
Olive oil	9,570	1,341	2,197	174	450	1,302	3,658	4,828	311	23,832
Other food	644	236	60	21	22	165	322	112	200	1,781
Horticultural products	315	2,136	1,073	1,175	499	468	424	80	46	6,217
Dairy products	14	199	755	896	6	41	360	164	292	2,729
Cereals and starch	24	37	34	54	151	106	786	2,345	173	3,711
Animal feed	1	7	0	26	94	12	430	48	25	643
Wine	6,981	95,747	11,507	6,353	6,976	20,241	29,588	6,115	56,521	240,028
Other drinks	109	104	4	11	12	417	185	204	260	1,305
Total	17,758	99,817	15,698	8,781	8,269	22,945	35,758	13,902	57,850	280,777

Source: authors' elaboration on ICQRF data.

5. FRAUDS IN WINE AND OLIVE OIL VALUE CHAINS: LOOING IN-DEPTH

5.1. Frauds in the wine value chain are mostly found in the processing phase

It is acknowledged that frauds in the wine sub-sector are numerous and various. The most important ones reported in various sources are: the use of sugar not derive from grapes, the use of alcohol not derived from fermentation, use of wine processing by-products such as the wine dregs, the use of table grapes, partial or total falsification of DOP and IGP wines, illegal processing operations, and incorrect labelling. For purposes of inspection and monitoring, it is always useful to classify the frauds using certain criteria such as their levels of irregularity, their impacts on health, as well as their potential positions in the value chain (INEA, 2011; Menghini and Fabbri, 2013).

A generally useful classification can be based on the impacts on health and can lead to the distinction of two major categories. The first is the one considered the most risky in terms of impact on human health and includes the use of substances and methods including the making of artificial wines. The second category is much less risky on human health, but with probably greater economic and commercial impact. This category contains fraudulent actions that imitate the appearance of quality products such as the exclusive character of the big brands or products of designation of origin. The fraud here is focused on deceiving consumers by the packaging and the message it conveys (De Franceschi, 2016).

It can be stated that while the first category is confined to the agents involved in the processing phase of the value chain (i.e. the cellars and the wine-making factories), the second category is spread over the value chain. As the opportunity to commit frauds of the second category depends on the commercialization level of the relevant agents, they are probably more concentrated within agents that perform bottling and distribution of wines destined for exports taking advantage of the of Italian sounding especially those with DOP and IGT whose prices may reach a few hundred euros per litre (De Franceschi, 2016).

In this section, we use a value chain approach to present and assess the ICQRF inspections and their results, and to examine the ICQRF inspection activities and their distribution among various agents to shed light on the intensities of inspections and detected irregularities. Based on this we provide some indications of potential risks of frauds in order to inform the ICQRF on potential improvements in inspection system. This requires first an understanding of the basic structure of the wine VC, its main agents and their

corresponding functions. To achieve this, we use the data and information published in literature relying mainly on Malorgio et al. (2011), Mazzarino & Corsi (2014), and ISMEA (2015).

According to Malorgio et al. (2011), the principal actors in the wine value chain farmers (grapes producers), wine cellar operators, and bottlers, with a total number of operators exceeding 300 thousands, of whom the majority (240 thousands operators) falls under the category of farmers. These are, in turn, classified into individual farmers and cooperative members with 52% and 48% of their total number respectively as of 2012 (Mazzarino & Corsi, 2014). The categories of cellar operators and bottlers account, instead, to about 66,500 and 8,000 respectively.

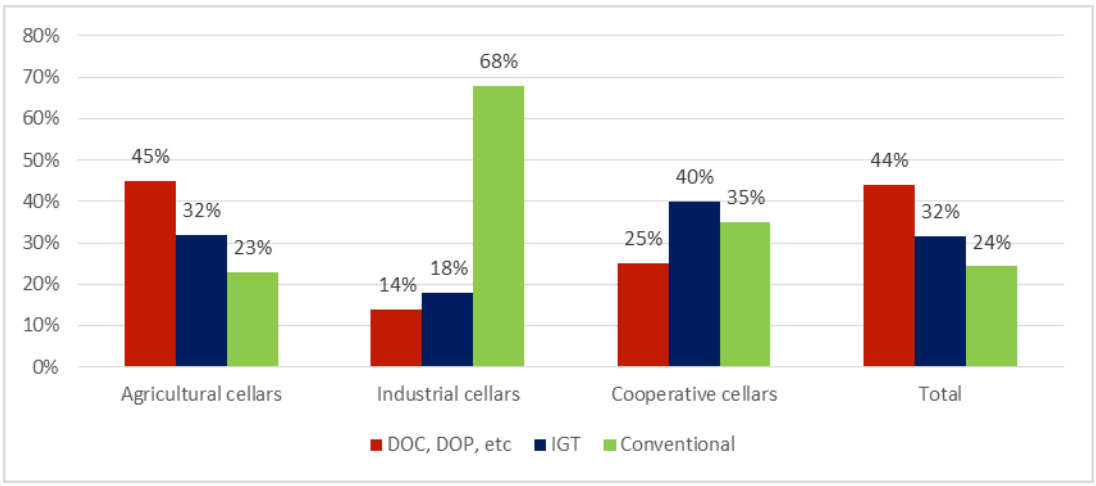
These three principal actors interact with each other and with other operators specialized in provision of diverse related services to determine the structure of the VC as a complex network of flows between actors with some being able to integrate more than one function. The processing phase is characterized by a high number (about 65 thousands) of small agricultural cellars, which are integrated with grapes farms that process their own grapes, supplemented sometimes with purchased grapes. On the other hand, industrial and cooperative cellars are fewer in numbers (less than 3% and 1%) but producing 29% and 49% of the total wine respectively.

The number of bottlers is the lowest among the three major agents of wine VC, and this is mainly due to costly equipment required to establish a bottling line in each cellar, resulting in numerous small cellars selling or resorting to mobile and/or fixed bottling plants, which mostly function as wholesalers too. Moreover, bottling operators are heterogeneous with some 20% considered as pure bottlers, while the rest integrates with bottling other functions, mainly grapes transformation into wine. This last category of bottlers contains almost all industrial and cooperative cellars, plus a small proportion of the agricultural ones (Malorgio et al., 2011).

The three major wine cellars (agricultural, cooperative and industrial) have different orientations in terms of quality characteristics of their major products. As shown in Figure 6, agricultural and cooperative cellars are more specialized in DOC and IGT, while the majority of industrial cellars (68%) produce only conventional wine.

Besides these three agents, there are other categories of agents involved in services associated with wine marketing such as exporters, importers, certification agencies, wholesalers and retailers. According to a recent study, bottlers mostly perform wholesaling, and so the category of bottlers-wholesalers is of a growing importance due to their multi-functions in the wine VC. These operators perform a double function; from one side, they connect wine producers to the stage of final distribution; on the other side, they are responsible of transportation and/or storage of wine output with, sometimes, its final sales, which may include also exports (Mazzarino & Corsi, 2014).

Figure 6. Wine producers' orientation in terms of product quality characteristics (2008)



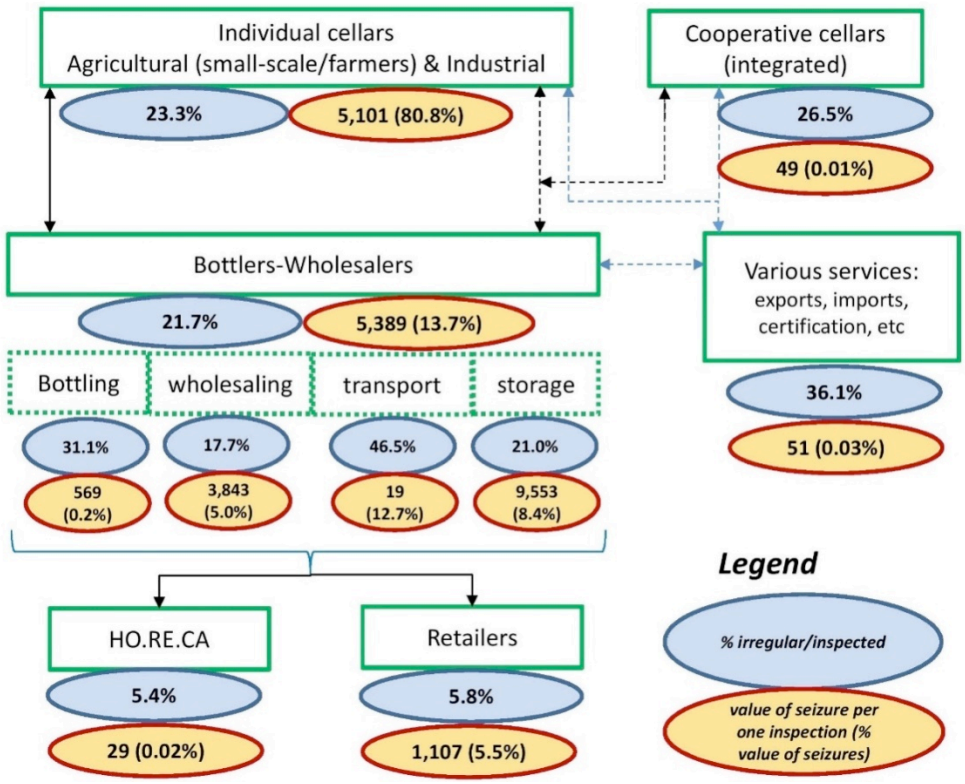
Source: authors' elaboration on data from Malorgio et al. (2011).

For assessing the intensity of detected irregularities along the value chain, we had first to sort the data according to the wine value chain phases described above. The sorting process was not immediate due to the absence of clear-cut criteria in the original ICQRF dataset. Therefore, we developed an *ad hoc* method relying principally on a variable called working position of agents (qualifica soggetto), which is the only field that includes information on the position of agents within the value chain. It has not been possible to distinguish industrial cellars from agricultural (small-scale) ones since no data are available on business dimensions. On the other hand, all establishments performing storage, transportation, wholesaling, and bottling have been considered under "bottlers-wholesalers". Therefore, the sorting has led to the classification of all establishments functioning in wine sub-sector into one of the following phases or/and functions: individual cellars (agricultural and industrial together), cooperative cellars, bottlers-wholesalers, service providers, retailers, and HO.RE.CA.

In addition, we calculated various indicators at each level of the value chain. These are the ratios of irregular establishments over the inspected ones, the value of seized products per one inspection, and the distribution of values of total seizures as proportions of total seizures. Figure 7, shows the basic structure of wine value chain together with the indicators.

By comparing ratios irregular/inspected establishments over all the VC phases, we see that the highest proportion of irregular establishments are found in service providers, whose number of inspections do not exceed, on average, 2% of total inspections. The intensity measured by irregular/inspection proportions are similar in the three major phases: cooperative cellars, individual cellars and bottlers-wholesalers with 26%, 23% and 22% respectively. Within the latter phase, intensities of irregularity vary considerably with transportation and bottling having intensities more than the average of the phase (46% and 31% respectively) while wholesaling and storage have lower intensities (18% and 21% respectively). Retailers and agents of HO.RE.CA have both low and similar proportions (about 5%).

Figure 7. Proportion of irregular/inspected establishments vs. value of seizures per inspections (euro) and distribution of values of seized products (%) along the wine VC (2007-2015)



Source: Authors' elaboration on ICQRF data.

As the majority of irregularities (95%) is detected within three agents (individual cellars, bottlers-wholesalers and retailers), it is expected to see a similar distribution for the values of seizures. In fact, these three agents are responsible for more than 99% of the total seizures, while service providers, HO.RE.CA, and cooperative cellars are responsible for only about 0.6%. The third measure of irregularity intensity is the value of seizures per one inspection in each phase. Here again, we see that the highest values are reported for bottlers and individual cellars respectively with approximately 5,100 and 5,400 euro/inspection. Another relatively high figure is reported for retailers (about 1,100 euro/inspection), while the remaining figures are all noticeably low (51, 49, and 29 euro/inspection for service providers, cooperative cellars and HO.RE.CA respectively).

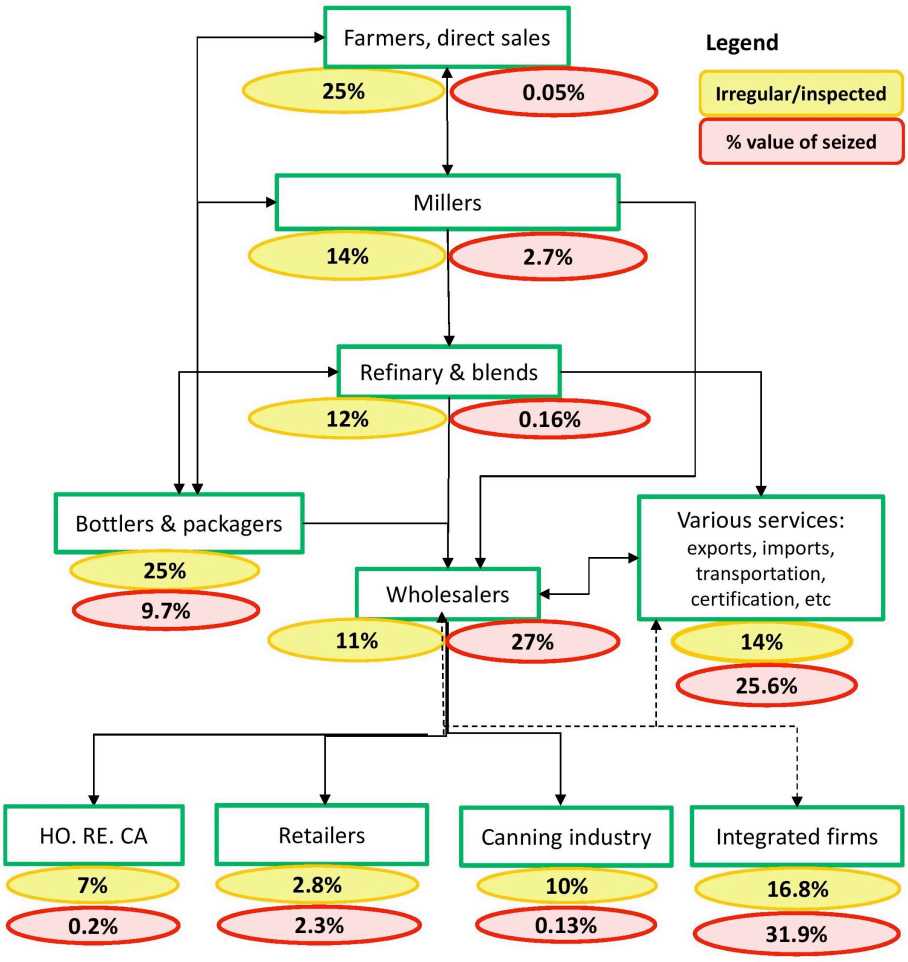
Given the above, the intensity of irregularity is low for cooperative cellars, HO.RE.CA, and service providers; and it is noticeably high for individual cellars and bottlers-wholesalers. Retailers lie in between. Comparing these findings with the numbers of inspections in each phase reveals that the two phases of the highest intensities are both under-inspected, while those with low intensities are over-inspected. In addition, retailers, who are over-inspected, have moderate intensity, are numerous in number, and is characterized by spatial dispersion. This can justify recommending the reduction of inspections in for retailers, HO.RE.CA, service providers and increase them for bottlers-wholesalers and individual cellars.

5.1. Olive oil frauds are concentrated in the integrated firms and service providers

As in the case of wine, for assessing the intensity of irregularities, we had to allocate the observations to the various stages of the olive oil value chain, for which we use the value chain structure presented in

ISMEA (2014). Then we computed the ratios of irregular establishments over the inspected ones and compared them among all the VC phases. This is shown in Figure 8 (yellow boxes), showing that the highest proportions of irregular establishments are found among farmers and bottlers (about 25% each), followed by integrated firms (17%). Millers and services come fourth and fifth with 14% each . On the other hand, retailers and HO.RE.CA have the lowest ratios. Comparing these findings with ICQRF data on numbers of inspection indicates that the value chain phases with higher intensities of irregularities are among the under-inspected ones, while those with lower intensity of irregularities are those over-inspected. This is evidence that the ICQRF may consider a reallocation of some inspection resources from retailers and HO.RE.CA to other phases of the VC.

Figure 8. Proportion of irregular/inspected establishments and distribution of seizures along the olive oil VC (average 2007-2015)



Source: Authors' elaboration on ICQRF data.

Service providers (i.e. storage, transportation and export-import) seem to be a special case. They seem to be sufficiently inspected (located on the red line in Figure 3.14), but they have relatively high proportion of irregularity (14% as shown in Figure 8) indicating a high intensity of frauds. This is confirmed by noticing that the products seized from these firms make more than 25% of the value of the total seized products in the olive oil VC. In fact, looking at the how the value of seized products are distributed along the VC adds a considerable weight to our understanding of the intensity of frauds.

Regardless of the proportions of irregular over inspected establishments, we notice that most of seizures in terms of values (95%) have occurred in only four phases of the VC, which are wholesalers, services, integrated firms and bottlers. On the other hand, the values of seized products from farmers, refineries & blenders, canning industry, and HO.RE.CA all together do not exceed 0.5% of the total values of seizures. This extremely uneven distribution of the values of seized products is another indication of irregularity intensity, but here expressed in terms of seriousness of some irregularities that call for the seizures of large quantities/values of the inspected products.

6. CONCLUSIONS

The analysis of food frauds over the period 2007-2015 reveals several important results. First, quality products such as DOC, DOP, and IGT show a rate of irregularities higher than that of organic and conventional products. This is probably linked to the higher expected payoff of frauds for these products, i.e. high economic opportunity (a characteristics shared with organic products), and more difficult detection due to more complicated standards (different from the case of organic products that have clearer characteristics). This explains, at least in part, the increased shares of these products in ICQRF inspections over the years.

The major result of geographical analysis is that the intensity of inspection activities seems to be unbalanced among regions. Therefore, the ICQRF may consider a redistribution of inspection activities reducing them in the regions with lower intensity of irregularities (mostly small regions) and increasing them in (larger) regions with higher intensities of irregularity such as Lazio and Lombardy, but also in Puglia, Veneto and Piedmont.

The analysis by subsector shows that wine and olive oil are the most inspected value chains: this is justified by their larger economic sizes and their higher exposure to frauds. Wine is also by far the sub-sector with highest intensity of irregularities, while olive comes fifth (after fish, other drinks and animal feeds), but when looking at seizures, wine and olive oil are by far the two sectors recording the highest fraud intensity. The values of seized wine and olive oil over 2007-2015 are 240 and 23 million euro respectively, making together more than 95% of the total seizures in terms of value.

The value chain based analysis on wine shows that the majority of irregularities (95%) is detected within three agents (individual cellars, bottlers-wholesalers and retailers), who are also responsible for more than 99% of the total seizures value. It is also interesting to highlight the difference between individual and cooperative cellars as the former is associated with very high intensity of irregularities while the latter has it very low. This difference in may be attributed to the fact that fraud opportunity is minimized in the cooperatives due to more transparency required to manage such enterprises. Therefore, to improve its monitoring, the ICQRF may consider to pay more attention to individual cellars, especially those who have integrated processing of wine with bottling and distribution. In addition, and although the data do not suggest any peculiarities for DOP and IGT wines compared to conventional ones, we believe, based on sector-level expert judgment, that more emphasis be given to processors DOP and IGT wines, especially those mostly involved with exports whose inspection and monitoring partially lie under the responsibility of ICQRF counterparts in the destination countries.

The value chain based analysis on olive oil reveals that the highest proportion of irregularities are found within the so-called integrated firms (firms that integrate processing with commercial activities including distribution to retailers and consumers). This might be attributed to a positive correlation between complications resulting from vertical integration and the capacities of firms to commit frauds as indicated in

the fraud triangle model (INEA, 2011). The millers and bottlers also show high proportions of irregularities. On the other hand, retailers and HO.RE.CA are over-inspected compared to their proportions of irregularities, while wholesalers and refiners & blenders have are inspected in a balanced manner.

In addition, the VC analysis reveals that more than 95% of the seized olive oil in terms of value occurred in only four phases: integrated firms (32%), wholesalers (27%), services providers (26%) and bottlers (10%). On the other hand, the values of seized products from farmers, refineries & blenders, canning industry, and HO.RE.CA all together do not exceed 0.5% of the total values of seizures. This extremely uneven distribution of the values of seized products is another indication of irregularity intensity, but here expressed in terms of seriousness of some irregularities that call for the seizures. Therefore, to improve its monitoring, the ICQRF may consider to switch some inspection activities from phases that are over-inspected (i.e. retailers and HO.RE.CA) to those that are under-inspected, especially the integrated firms, millers and bottlers. In addition, special caution should be given to integrated firms, services (especially storage), wholesalers and bottlers for their high share in seizures value, an indication of more dangerous irregularities.

Nevertheless, in order to provide more specific advice to further increase efficiency, there is a need for mode detailed research. A detailed risk analysis on subsectors can help in identifying specific features in each value chain, that will prove useful in improving monitoring activities. However, in order to perform a proper risk analysis, additional data are needed. Variables describing the most important economic characteristics of agents such as the economic size of the firm, its production mix, and its juridical status. In addition, socio-demographic data are essential to characterise the firm behaviour such as the owner gender, the education level and the family size. Unfortunately, these data are not available at the moment.

AKNOWLEDGMENTS

This paper is a product of a joint research project between the Department of Economics and Management (DISEI) of the University of Florence (UNIFI) and the Council for Agricultural Research and Analysis of Agricultural Economics (CREA) on "Risk Analysis and Evaluation of Frauds in the Agrofood System". The authors would like to thank the staff and the management of CREA for their continuous support, especially the technical support provided by Antonio Pepe for the production of maps. Special thanks also to the ICQRF staff and management for their continuous availability for meetings and discussions, namely Dr. Stefano Vaccari (ICQRF Director), Dr. Luca Veglia (Head of Risk Analysis Office), and Dr. Placido Iudicello (Data manager) for their support in providing data and feedbacks on preliminary results. Special thanks also to the Institute of International Education/Scholar Rescue Fund (IIE-SRF) for its financial support to Dr. Ahmad Sadiddin, a Syrian refugee scholar: Without the IIE-SRF support, the Project would never materialize.

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An Assessment of Agro-food Frauds in the Italian Economy: A SAM-based Approach

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Paper prepared for presentation at the 6th AIEAA Conference
"Economics and Politics of Migration: Implications for Agriculture and Food"

15-16 June, 2017
Piacenza, Italy

Summary

This paper estimates the impact of food frauds on the Italian economy over the period 2007-2015 using a social account matrix (SAM) model in an original counterfactual framework.

The results of the SAM simulations show that the share of economy directly and indirectly linked to supply of irregular food products accounts for 0.5% of total value of output and 0.6% of total employment. Focusing on the agro-food sector, the total output driven by irregular products is much higher accounting for 3.2% of output and 5.8% of employment.

The heavy dependence of some value chains on the demand met by irregular production makes them vulnerable to food scandals/scares especially if they feature relatively large price elasticities. Wine seems to be the most fragile value chain considering that roughly 25% of its demand is met by irregular production.

Results from the counterfactual analysis shows that the net impact of food frauds on GDP is positive though very small (-0.06%) since the earnings feed rent-seeking activities instead of strengthening linkages with the rest of the economy. Looking at the agro-food system, the relative impact on output is far more important in agriculture (up to -1%) than in the food industry (from -0.03% to -0.33%).

Keywords: food frauds, impact analysis, Italy

JEL Code: C69; L66; Q18.

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1. INTRODUCTION

Food frauds have been rapidly growing worldwide over the last decades. In fact, as food supply chains become more complex and global, companies have less visibility and control of key processes and monitoring agencies have less ability to detect frauds. More recently, this situation has been exacerbated by the global recession as suppliers were squeezed by costs and had stronger incentives to surrender to temptation to commit food fraud.

Fraud resulting in a food safety or public health risk event could have significant financial or public relations consequences for a food industry or company.[1] According to the UK Food Safety Agency food frauds affect approximately 10% of all commercially sold food products (Everstine and Kircher, 2013) and the overall cost to global industry is estimated to be in the range between $10-15 billion (Johnson, 2014) and $30-40 billion (Rey, 2014).[2] However, these estimates are likely to represent only a fraction of the true cost, because the full scale of food fraud may be unknown or even possibly unknowable (Spink and Fejes, 2012) since the goal of adulteration for economic gain is not to be detected. Moreover, these estimates are generally based on expert guesses rather than on a systematic and rigorous account of food fraud episodes.

This paper aims at filling this knowledge gap with specific reference to Italy, using primary data provided the Authority in charge of the monitoring and repression of frauds in all food value chains, and assessing the economic impact of food frauds using a social account matrix (SAM) of the Italian economy to simulate the impact of fraudulent activities on output and employment.

Italy is indeed an excellent case to study food frauds. The food sector is one of the most important sector of the 'Made in Italy'[3] and represents one of the most profitable sector for fraudulent activities all over the world. The so-called 'Italian sounding' that is the misleading use of Italian brand names worldwide has been estimated to have a turnover more than 2.6 times larger than the value of Italian agro-food export (Eurispes, 2011), while the revenue from food counterfeiting has been estimated at 16% of total counterfeiting activities in the country (CENSIS, 2012).

The provision of the data on seizures and irregularities detected by the Central Inspectorate for Quality Protection and Frauds Repression of Agro-food Products (ICQRF) over the years 2007-2015 offers a unique

[1] In most cases the impacts of food fraud on consumers are not harmful but there are some notable exceptions such as the methanol scandal in the wine industry in Italy in 1986 and the milk adulteration with chemical melamine in China in 2008, both causing many hospitalizations and even some deaths.

[2] The Grocery Manufacturer Association (GMA, 2010) estimates that one product adulteration incident averages between 2% and 15% of annual revenues in terms of lost sales as well as possible bankruptcies if adverse public health consequences occur. This could translate to a $400 million impact for a $10 billion company, or a $60 million impact for a $500 million company.

[3] Italy is indeed the EU country with the largest number of protected agro-food products accounting to 288 protected designations of origin (PDOs), protected geographic indications (PGIs) and traditional specialties guaranteed (TSGs), and to 523 protected denominations and geographic indications wines (DOCG, DOC and IGT).

opportunity to shed some lights on the recent evolution of food frauds in the country and to assess the impact of these frauds on the Italian economy.

In pursuing this objective, the paper is organized as follows. Section 2 provides an overview of food frauds in Italy between 2007 and 2015. Section 3 illustrates how the impact evaluation can be modeled in a SAM framework. Section 4 shows how a SAM has been developed to obtain a model of the Italian economy suitable for the purpose of this paper. Section 5 discusses the results of the impact evaluation analysis assessing firstly what are the output and employment generated by fraudulent activities in the food sector and secondly a counterfactual analysis of the impact of food frauds. Section 6 summarizes the main findings and discusses the main policy implications.

2. FOOD FRAUDS IN ITALY

2.1. Inspections and seizures in Italian food value chains

Despite there are many bodies involved in the repression of agro-food frauds in Italy, the ICQRF is the only authority performing systematic inspections based on representative samples that cover the whole national domain across all food value chains. The information of ICQRF inspection activities are disaggregated per geographic areas (regions and provinces) and at agro-food subsector level, spanning over the period 2007-2015 (ICQRF, 2016). When a fraud is detected, the consequence might be either the seizure of the relevant product or/and the imposition of a fine. The ICQRF uses the term 'irregularity' to describe both cases. Therefore, the set of seized products is just a sub-set of irregular products.

In this paper, we adopt a broad definition of food fraud, as proposed by Spink and Moyer (2011), including any kind of fraudulent action such as food alteration, adulteration, sophistication, and falsification of agro-food products as well as counterfeiting, that is the falsification of their trademarks including those related to the indication of geographical origin. Operationally, this means that a food fraud exists whenever a ICQRF inspected product features any kind of irregularity no matter if it leads to the confiscation of the product or to other administrative penalties such as fines and warnings. Therefore, any good produced making any type of fraud is identified as 'irregular product', while the agent that makes the fraud on the relevant product is called 'irregular establishment'.

Table 1. Summary of the ICQRF inspections by sub-sector over 2007-2015

Subsectors	Number of inspections by afro-food sub-sector		Distribution of inspections by agro-food sub-sector		% of irregularities/inspections	
	Products	Establishments	Products	Establishments[a]	Products	Establishments
Meat products	29,698	13,026	5.8%	12.0%	9.22%	13.83%
Fish products	1,280	884	0.3%	0.8%	12.42%	12.10%
Olive oil	70,419	26,882	13.8%	24.8%	8.45%	12.71%
Other foods	40,332	18,363	7.9%	17.0%	7.65%	11.41%
Horticultural products	68,086	21,670	13.4%	20.0%	5.09%	9.95%
Dairy products	57,703	19,554	11.3%	18.1%	6.79%	11.81%
Cereal products	47,335	17,699	9.3%	16.4%	6.93%	11.43%
Animal feed	29,169	9,013	5.7%	8.3%	9.29%	12.06%
Wine	150,889	33,504	29.7%	31.0%	13.94%	25.51%
Other drinks	13,669	5,867	2.7%	5.4%	10.25%	13.81%
Total	508,580	108,203	100.0%	153.8%	9.39%	21.07%

[a] The proportions of inspected establishments do not sum to 100% because many establishments (e.g. retailers, processors and wholesalers) supply products belonging to different value chains.
Source: ICQRF (2016)

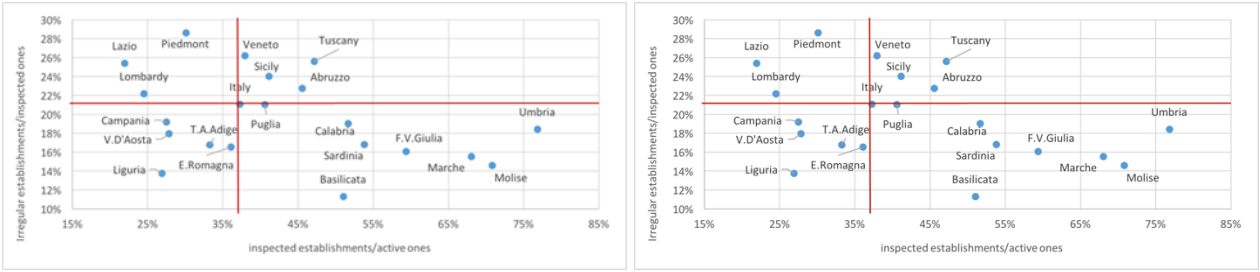
A summary of inspection activities and outcomes performed by ICQRF is reported in Table 1. Wine is the most inspected product accounting for about 30% of total inspections, followed by olive oil, horticultural and dairy products, accounting for 14%, 13% and 11% respectively. By and large the same ranking applies

also to establishments. In terms of proportions of irregularities compared to the number of inspections, wine also ranks first: 14% in terms of products and 26% in terms of establishments. Other important subsectors are fish, other drinks, animal feeds and olive oil all ranging between 10% and 12% in terms of irregular products and around 12-13% of irregular establishments.

2.2. Regional and subsector disaggregation of food frauds

To get some insights on the intensity of irregularities we look at the ratio of seized products to irregular ones as well as the ratio of irregular products to inspected ones. The left panel of Figure 1 plots the two ratios against each other with the red axis representing the national averages. The figure shows that frauds are more intense in Veneto, Lazio, Piedmont, Lombardy, and Puglia, followed by Sicily, Tuscany, Campania and Friuli V.G. The right panel of Figure 2.1 plots the ratio of irregular establishments to inspected ones against the ratio of inspected establishments to active establishments in each region. It shows that Piedmont, Lazio and Lombardy have been noticeably under-inspected, while regions such as Molise, Marche, Sardinia Basilicata and Calabria are considerably over-inspected. Therefore, a redistribution of inspection activities may improve the ICQRF performance through reducing the inspections in the latter regions and increasing them in the former ones.

Figure 1. Intensity of food frauds per regions: products (left panel) and establishments (right panel).

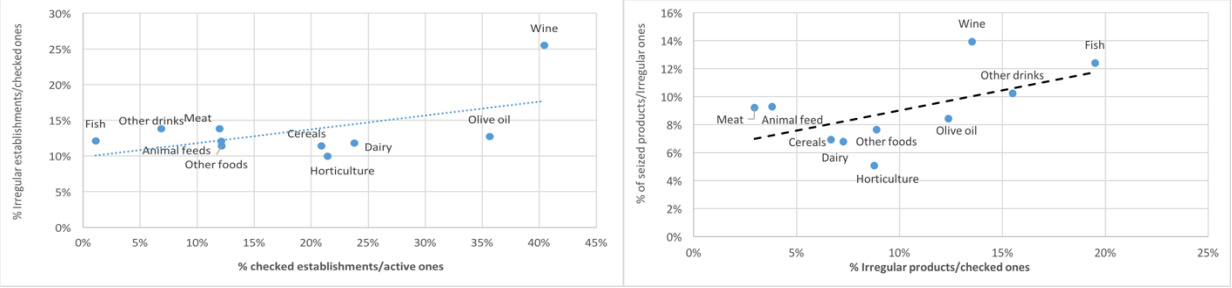


Source: authors' elaboration from ICQRF (2016) and ISTAT (2014)

We replicated the same analysis to assess the intensity of irregularity per subsector (Figure 2). In terms of products (left panel), the picture shows that the intensity of irregularity is higher than the averages for wine, fish, other drinks and olive oil. All the other subsectors show an intensity of irregularities lower than the average. In terms of establishments, wine and olive oil seem to be well monitored while the ones towards the bottom left corner (e.g. animal feed and other food producers) appear to require more attention by the monitoring body.[4]

[4] Specifically, we found a significant statistical relationship between the two ratios by regressing the ratio of seized/irregular products over the ratio of irregular/inspected products (Figure 2.2, left panel). The correlation coefficient of the regression is found to be statistically significant at 10% of the significance level despite the few number of degrees of freedom. Performing the same analysis regressing the ratio of irregular/inspected establishments on the ratio of inspected/active ones (Figure 2.2., right panel) the correlation coefficient is significant only at 15%.

Figure 2. Intensity of food frauds per subsectors: products (left panel) and establishments (right panel).



Source: authors' elaboration from ICQRF (2016) and ISTAT (2014)

2.3. Value of seized and irregular food products

To assess the value of irregular products we need first to estimate these values at the sample level and then expand them to the population level. At both levels, we have two different figures that can be meant as a lower and an upper bound of detected food frauds. In fact, ICQRF reports estimated monetary values for seized product (lower bound), which are only a subset of irregular products. For irregular products (upper bound) only quantities are reported by ICQRF.

Therefore, we estimated the monetary value of irregular products at sample level applying as rate of expansion the ratio of the number of irregular products to seized products (Table 2.2). The value of seized and irregular products at sample level have been then expanded at the population level through appropriate expansion coefficients reflecting the various subsector sampling rates of the original ICQRF sample. Table 2. summarizes the average yearly value of seizures and irregular products per each subsector expressed in constant monetary terms (euro 2009).[5] As expected, wine is by far the largest subsector both in terms of value of seizures and irregular products.

Table 2. Values of seized and irregular products: population level estimation (constant 2009 euro)

Sector	Sample level			Population level		
	Values of seizures (000 euro)	Expansion rate	Values of Irregularities (000 euro)	Sampling rate	Values of seizures (000 euro)	Values of irregularities (000 euro)
Meat products	55	3%	1,675	2.00%	2,803	85,121
Fish products	29	18%	161	0.20%	19,188	107,049
Olive oil	2,748	16%	17,306	6.30%	43,577	274,433
Other foods	278	10%	2,890	2.20%	12,555	130,298
Horticultural products	964	8%	11,462	3.80%	25,588	304,352
Dairy products	430	8%	5,233	4.80%	9,056	110,179
Cereal products	614	6%	10,921	3.70%	16,678	296,530
Animal feed	106	7%	1,561	61.40%	172	2,544
Wine	39,030	18%	219,292	8.30%	470,740	2,644,843
Other drinks	212	19%	1,126	1.00%	21,844	115,818
Total	44,467	--	271,627	--	622,201	4,071,167

Source: Authors' elaboration on ICQRF (2016) and ISTAT (2014).

[5] Considering that figures will be used for SAM simulations, year 2009 is a convenient year to refer these values because it is the reference year of the SAM. Furthermore, recalling that the simulations are modelled in a SAM framework as exogenous shocks (cf. section 3), all quantities have been transformed as if they were at final consumption stage, using proper technical coefficients according to the subsector and the relevant level within the value chain.

3. MODELLING THE IMPACT OF FRAUDS IN A SAM FRAMEWORK

Linear models based on social accounting matrices are typically demand-driven. Given the structure of interdependencies within the economy, the activation of the economy depends on the magnitude of a vector of exogenous inflows towards accounts considered as endogenous in the model. Simulations are usually carried out hypothesising changes in the vector of exogenous shocks to calculate (via post-multiplication to the matrix of multipliers) a vector of changes in the totals of endogenous accounts:

$$d\mathbf{y} = \mathbf{M}d\mathbf{x} \quad (1)$$

where $d\mathbf{x}$ is a vector of changes in exogenous injections, representing a given scenario to be assessed, and $\mathbf{M}$ is the matrix of SAM multipliers.

The impact assessment of food frauds within a SAM framework can essentially follows two approaches, operating on the two terms on the right-hand side of equation (1). A first approach simply estimates the impact of final demand that in the current configuration of the Italian agro-food system is supplied by seized and irregular products (that represent the lower and upper bounds of food frauds). In order to do this, equation (1) is used with $d\mathbf{x}$ being a vector composed by the estimated values of seized and irregular food products. This exercise allows assessing the share of the economy directly and indirectly relying (via the circular flow) on food fraud activities. We interpret the results of this exercise as a measure of vulnerability of the agro-food production system. Indeed, food frauds brings about an inherent risk of trust loss by food consumers should a food scandal/scare happen. In this case, the larger the share of the final demand supplied by fraudulent products the higher the risk of a system disruption.

A more thorough analysis can be carried out introducing changes in the matrix $\mathbf{M}$ adopting a counterfactual approach. The SAM represents the *actual* flows in the economy, including both regular and non-regular food production activities. The direct expenditure coefficients derived by the SAM and used in calculating the matrix $\mathbf{M}$ depict the *average* structure of intermediate consumption for different subsectors of food industry, reflecting their composition in terms of regular and non-regular activities. However, it is reasonable to assume that the structure of costs in a production activity not complying with regulations and standards is different from that of a fully-complying production unit.

Overall, we expect that an irregular food would be obtained increasing the ratio between value added and intermediate costs, and increasing the share of profits in the primary distribution of value added to factors. Such a different configuration of costs decreases the backward linkages of the irregular production activity, reducing its ability to activate the economic system through industrial interdependencies. Furthermore, the increased share of distributed profits is likely to change the impacts on the economy via the income distribution, i.e. the final consumption expenditure path. A counterfactual analysis of the impact of irregular activities should compare the total activity of the actual economy represented in the SAM, with that of a hypothetical economy of fully-complying (i.e. not making frauds) firms.

Suppose a matrix $\mathbf{B}^*$ of SAM based direct expenditure coefficients representing a fully-compliant production system is available. The corresponding matrix $\mathbf{M}^*$ of SAM multipliers could be calculated. In turn, the total impact of irregular production activities could be estimated as follows:

$$\mathbf{c} = (\mathbf{M} - \mathbf{M}^*)\mathbf{x} = \mathbf{y} - \boldsymbol{y}^* \quad (2)$$

where, $\mathbf{x}$ is the vector of *actual* (SAM-based) exogenous inflows towards the endogenous accounts, $\mathbf{y}^*$ is the vector of totals of endogenous accounts that would be observed should the production system be fully-

compliant, and **c** estimates the impacts of irregular activities expressed as changes in the totals of endogenous accounts.

Such a counterfactual analysis requires additional data on how non-compliance affects the vector of costs of production activities in different food subsectors. Let $\mathbf{A_f}$ be the matrix of expenditure coefficients for non-regular production activities and *f* the vector of total values of irregular productions. The use matrix $\mathbf{Z_f}$ representing total intermediate consumptions for non-regular production activities can be calculated as follows:

$$\mathbf{Z_f} = \mathbf{A_f}\hat{\mathbf{f}} \tag{3}$$

where the hat indicates the diagonalization of vector **f**. The use matrix for fully-compliant production activities can be obtained by the difference:

$$\mathbf{Z_r} = \mathbf{Z} - \mathbf{Z_f} \tag{4}$$

where, **Z** is the use matrix in the original SAM.

Finally, matrix $\mathbf{A}^*$ can be obtained dividing the elements of $\mathbf{Z_r}$ by the total value of regular products:

$$\mathbf{A}^* = \mathbf{Z_r}(\widehat{\mathbf{y} - \mathbf{f}})^{-1}. \tag{5}$$

Matrix $\mathbf{B}^*$ representing the "fully-compliant" (i.e. counterfactual) economy is obtained substituting the 'modified' use matrix $\mathbf{A}^*$ for the matrix of direct expenditure coefficients of production activities in matrix **B** obtained from the original SAM.

4. SAM BUILDING

Modelling the agro-food sector in an input-output and SAM framework has a long-lasting tradition in Italy.[6] This study follows the same approach extending it to obtain a complete SAM representation of the Italian agro-food system suitable for the purpose of the analysis. The input-output table of the economy for 2009 (ISTAT, 2016) was disaggregated to include 8 groups of farms with different productive specialisation and 10 different groups of food manufacturing activities. All these activities produce a set of 11 different commodities.[7]

Furthermore, the disaggregated table was merged into a SAM of the Italian economy developed by the Regional Institute for Economic Planning of Tuscany for the same year[8] (IRPET, 2016). The final SAM includes a total of 183 accounts including 64 commodities, 54 industries, 12 accounts for primary income distribution, 23 final consumptions functions, 18 accounts for current income use of institutions, 9 accounts to represent capital formation and 3 accounts for flows with the Rest of the World. Households are disaggregated into 10 groups according to deciles of equivalent per-capita available income. Institutions purchase bundles of goods and services corresponding to 23 final consumption functions. Agriculture and food industry sell their products to consumers throughout the first two functions referred to as purchases of

[6] Input-output tables with highly disaggregated agriculture and food sectors have been produced by ISMEA at regular intervals (IRVAM, 1987; ISMEA 1997; ISMEA, 2009). ISTAT also produced a version of the input-output table of the Italian economy for 1992 with the agro-food sector disaggregated into 10 industries (ISTAT, 2002).

[7] Details on data and methods used in building the disaggregated table can be found in (Rocchi et al., 2016).

[8] IRPET built a multiregional (20 regions) SAM of the Italian economy with reference to year 2009 based on ISTAT official national accounting data for the same year.

food and beverages. The model closure assumes Government, Capital formation and Rest of the world as exogenous accounts.

Developing a counterfactual in a SAM framework would require additional information on frauds that, by definition, are difficult to obtain. Considering the huge diversification of production processes in the food industry, getting the relevant information would require an extensive survey. An alternative, adopted in this study, is to ask food sector experts and key informants working in organizations in charge of inspections in the agro-food sector to provide their best guess on the cost structure of various fraudulent production processes. This would make possible to build matrix $\mathbf{B}^*$ according to the procedure summarized in section 3. This procedure deserves specific attention for the wine and the olive oil industries, two sub-sectors that are strategic for Italian food system and largely affected by frauds. In this case experts and key informants were asked to provide first a description of the most common frauds in each subsector, taking also into account the different possible configurations of the process in different typologies of production units (for instance farm-based or industrial production activities). Then, they were asked to modify the coefficients in the **B** matrix (based on actual SAM flows) to better represent the cost vector of each fraudulent activity.[9]

For other food subsectors, we assumed that the adoption of irregular practices in production was able determine the same advantages enjoyed on average by the operators in the wine and olive oil industry. Only the cost of professional and legal services was assumed to maintain the same share on the total value of production of the averages activities represented in the SAM. These hypotheses are quite strong and simplistic. However, the analysis can still provide useful insights on the economics of agro-food frauds in Italy if we consider that the value of irregular products other than wine and olive oil represents a minor share of the total (27%).

5. RESULTS AND DISCUSSION

5.1. The vulnerability of Italian economy to food frauds

In this section, we report the results of the first approach, i.e. using vector *dx* in eq. (1) of seized and irregular product as an exogenous shock on the Italian economy, to assess the share of economic activities directly and indirectly activated (via the circular flow in the economy) by the final demand actually met by supply of fraudulent food products.

The production that between 2007 and 2015 has been activated every year amounts to a value ranging on average between €1.9 and €13.9 billion (Table 5.1). These figures clearly show the importance of the agro-food frauds in the Italian economy. In the reference period, between 0.1% and 0.4% of value added (a proxy of GDP) was generated by food frauds. These figures corresponded to a share of total employment accounting up to 156 thousand labour units when all irregular products are considered.

Table 3. Share of total economy activated by the final demand for irregular food products (value/year in €2009, average 2007-2015)

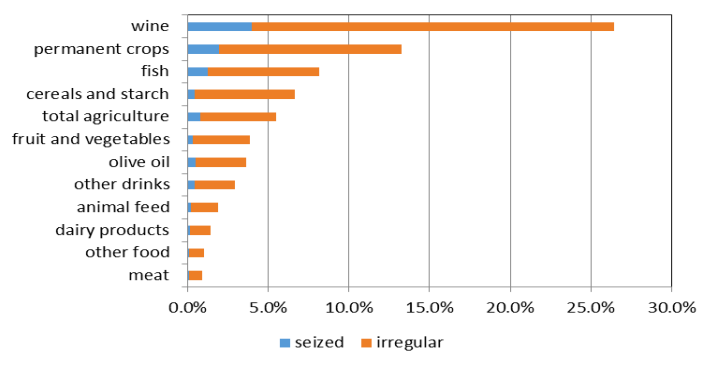
	Only seized products		All irregular products	
Total value of irregular food (M€)	622		4,693	
Share of total output (M€)	1,858	0.1%	13,879	0.5%
Share of total employment (000 LU)	22	0.1%	156	0.6%
Share of value added (M€)	795	0.1%	5,828	0.4%
Share of households' gross income (M€)	715	0.0%	4,754	0.3%

Source: Authors' elaboration.

[9] Details on the hypotheses made in developing this exercise are provided in (Sadiddin et al., 2016a and 2016b).

The share is even more important when considering as reference the agro-food system (Figure 5.1). The size of production activated by the final demand fraudulent food products varies across subsectors, but is particularly important (more than 25% when considering all irregular products) for wine and the connected activity of specialized permanent crops farms (11.3%). Overall, the total output driven by food frauds accounts for 3.2% of agro-food output and 5.8% of total employment in agro-food sectors. These results provide a measure of the agro-food production system vulnerability to food scares and scandals.

Figure 3. Share of the output of agro-food subsectors activated by the final demand food frauds



Source: Authors' elaboration.

An economic measure of the exposure of the food sector to the risks of frauds is a policy relevant result, though not yet a genuine measure of the impact of agro-food frauds on the economy. In fact, even though a potential source of instability, the irregular food production activities generate and distribute (illegal) incomes and activate the economy throughout backward and forward linkages. However, the presence of such activities may have a negative impact on the economy as the counterfactual analysis will show.

5.2. The impact of agro-food frauds: a counterfactual analysis

What the level of activity of the economic systems would be if all production activities were carried out complying with regulations and standards? To answer this question, a counterfactual analysis is needed.

Table 4. Impact of irregular production activities (value/year in €2009, average 2007-2015)

Type of impact	Only seized products		All irregular products	
	Absolute value	% impact	Absolute value	% impact
Impact on total output (M€)	-139	0.00%	-1 827	-0.06%
Impact on total employment (000 LU)	-2	-0.01%	-20	-0.08%
Impact on value added (M€)	6	0.00%	87	0.01%
Impact on households' gross income (M€)	-16	0.00%	-174	-0.01%

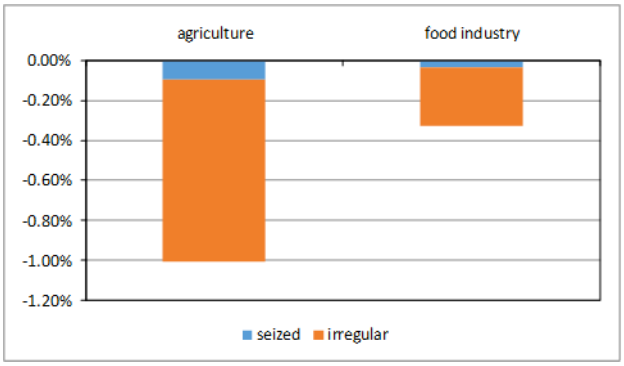
Source: Authors' elaboration.

The presence of frauds in food production decreases the total level of activity in the economy (Table 4): up to €1.8 billions of total output in all sectors of the Italian economy are potentially lost, corresponding to about 20 thousand full time labor units. In times of high underemployment, this is a striking figure. The income distributed to households is decreased too (up to -0.01%). Interestingly, the net impact on value added is positive though small. The extra-profits produced by fraudulent activities partially offset the reduction due to the loss of productive activities, even though forward linkages are not able to activate the economy (throughout final demand) and generate employment and income. The insight is that the largest parts of these profits are likely to be sterilized in non-productive assets and/or transferred outside the

economic systems. These results provide a fairly clear evidence of the existence of *rents from frauds* negatively affecting the viability of the economic system.

As expected the relative impact on the agro-food system is sensibly larger. The relative impact on output is far more important in agriculture (up to -1%) than in the food industry (between -0.03% and -0.33%) (Figure 4). The lower intrinsic quality of irregular food production reduces the value of agricultural input used per unit of processed food.

Figure 4. Impact on total output in the agro-food sectors (percentage changes, average 2007-2015)



Source: Authors' elaboration.

Table 5 shows the breakdown of the estimated impacts by subsector when the value of total irregular production is considered. Overall, the agro-food sector loses more than 13,700 labor units, mostly concentrated in agriculture, where the productivity of labour is typically lower and where the loss in terms of output is higher. The impact is different across different production activities, ranging from 0.17% in the "Other food" subsector to 1.28% in the "Fish products" industry. Interestingly, the wine sector is one of the most impacted by frauds with a contraction of 1.06% of its output and a loss of 218 labor units. Coupling this result with that of specialized permanent crops, which includes farms producing a relevant share of wine (and olive oil), the picture is even more gloomy: this component of agriculture loses 1.0% of its potential output and more than 5,300 labor units because of food frauds.

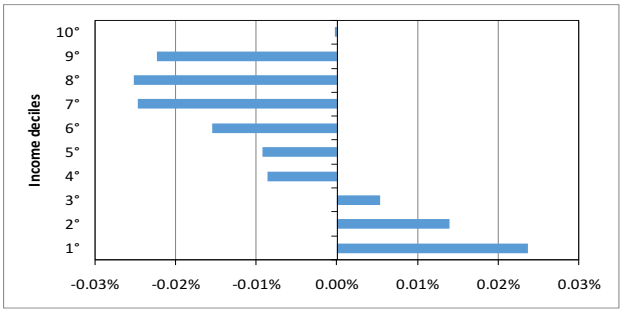
Table 5. Impact on output and employment in the agro-food sectors (percentage changes, average 2007-2015)

Sub-sectors	All irregular products	
	% total output	Labor units
Meat and production of meat products	-0.16%	-102
Processing and preserving of fish, crustaceans and mollusks	-1.28%	-74
Production of olive oil	-0.47%	-15
Manufacture of other food products	-0.17%	-368
Manufacture of processed vegetables and fruits products	-0.22%	-63
Manufacture of dairy products	-0.37%	-192
Manufacture of grain mill products, starches and starch products	-0.74%	-72
Manufacture of prepared animal feed	-0.78%	-90
Production of wine	-1.06%	-218
Manufacture of other beverages	-0.25%	-77
Specialized fields crop	-1.03%	-2,681
Specialized permanent crops	-1.00%	-5,335
Total agriculture	-1.00%	-12,507
Total food industry	-0.33%	-1,271

Source: Authors' elaboration.

A further interesting result concerns the redistributive effect of these impacts. Table 4 shows that the presence of frauds in the agro-food sector decreases the gross income earned by households up to 174 M€. Figure 5 shows how such an impact is distributed among deciles of equivalent per-capita income. The impact seems to be slightly progressive, benefitting the lowest deciles and negatively affecting more the income of higher deciles. A relevant exception is represented by the highest decile, whose income is virtually not affected. However, the changes in the relative position of groups in income distribution generated by frauds are likely to be small.

Figure 5. Impact on households' gross income (percentage changes by income deciles, average 2007-2015)



Source: Authors' elaboration.

6. CONCLUDING REMARKS

This paper, taking advantage of the opportunity to have access to the largest dataset on food frauds in Italy, provides an overview of food fraudulent activities in the country and estimates the impact of such activities on the Italian economy.

Data on the intensity of inspection activities show that monitoring activities seems to be unbalanced across regions. Therefore, the monitoring authority may consider a redistribution of inspection activities reducing them in the regions with lower intensity of irregularities (mostly small regions) and increasing them in (larger) regions with higher intensities of irregularity such as Lazio and Lombardy.

The analysis by subsector shows that wine and olive oil are the most inspected value chains: this is justified by their larger economic sizes and their higher exposure to frauds. Wine is also by far the sub-sector with highest intensity of irregularities, while olive comes fifth. However, there are subsectors (such as fish and animal feeds) where the intensity of inspection, also considering the intensity of irregularity, may be improved.

The results of the SAM simulations show that the share of economy directly and indirectly linked to supply of irregular food products accounts for 0.5% of total value of output. This corresponds to a value of €1.9 billion (considering only seizures) to €13.9 billion (including all irregular products) and is able to activate up to 156 thousand labour units (0.6% of total employment) in the worst-case scenario. Focusing on the agro-food sector, the total output driven by irregular products is much higher accounting for 3.2% of output and 5.8% of employment.

The heavy dependence of some value chains on the demand met by irregular production makes them vulnerable to shocks as the ones deriving from food scandals/scares, especially if they feature relatively large price elasticities. Wine seems to be the most fragile value chain considering that roughly 25% of its demand is met by irregular production. This translates, through backward linkages, into a 11% of the demand for products of permanent crops.

Results from the counterfactual analysis shows that the net impact of food frauds on GDP is positive though very small since the earnings feed rent-seeking activities instead of strengthening linkages with the rest of the economy. The extra-profits produced by fraudulent activities are likely to be saved in non-

productive assets and/or transferred outside the economic systems. Looking at the agro-food system, the relative impact on output is far more important in agriculture (up to -1%) than in the food industry (from -0.03% to -0.33%).

AKNOWLEDGMENTS

The authors thank the Italian Council for Agricultural Research and Analysis of Agricultural Economics (CREA), namely Dr. Raffaella Zucaro and Dr. Veronica Manganiello for their continuous support and help in understanding the intricacies of olive oil and wine value chains.

The authors would also like to thank the staff and management of the Central Inspectorate for Quality Protection and Agro-Food Fraud Repression (Ispettorato Centrale per la Qualità e la Repressioni delle Frodi, ICQRF), namely Dr. Stefano Vaccari (ICQRF Director), Dr. Luca Veglia (Head of Risk Analysis Office), and Dr. Placido Iudicello (Data Manager), for providing primary data on seizures and irregularities as well as providing feedbacks on preliminary results.

Important contributions were also provided by Dr. Amedeo De Franceschi, Head of the Agro-food Unit of the Italian Forest Service (Nucleo Agroalimentare e Forestale del Corpo Forestale dello Stato), and Dr. Pietro Sandali, Director of the Italian Consortium of Olive Producers (Consorzio Olivicolo Italiano, UNAPROL), Dr. Dario Parenti (oenologist) providing data and discussing the most important fraud modalities in the wine, olive oil and dairy value chains.

Last but not least, the authors wish to thank the Regional Institute for Economic Planning of Tuscany (IRPET) for providing the base 2009 national SAM for research purposes.

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