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Food fraud: economic insights into the dark side of incentives

Mariah Dolsen Ehmke, Alessandro Bonanno, Kathryn Boys and Trenton G. Smith†

In this review, we contextualise the articles in this special issue, relating them to existing food fraud research, and identify food fraud research trends, challenges and priorities for the near term. We accomplish these aims through a comprehensive review of research by food scientists, economists, other social scientists, legal experts, government research groups and international trade organisations. Existing food fraud research is heavily weighted towards food science, packaging and labelling, and legal areas of knowledge discovery. Moving forward, research is needed pertaining to general economic welfare outcomes from food fraud incidences, economic incentives to deter frauds, economic spillovers from fraud incidences to other food products and markets (domestic and international) and further delineation of the effect of different types of food fraud on consumer and producer welfare. The articles in this special issue make significant contributions to understanding of the role of food fraud in consumer decisions, measuring consumer welfare losses from fraud, food fraud spillover effects to other markets and new frameworks for fraud analysis.

Key words: food fraud, international trade, consumer demand, lemons equilibrium, labeling, asymmetric information, welfare.

1. Introduction

Food fraud threatens agri-food businesses, processers, consumers and producers' global well-being (Agnoli *et al*. 2016; Kendall *et al*. 2019; Nestlé 2016; NFU Mutual 2018). Recent food chemistry, spectrometry and molecular biology technology advancements improve food fraud detection, providing some assurances (e.g., Medina *et al*. 2019; Torreblanca-Zanca et al. 2019). Yet, food frauds persist. While technology innovations enable better fraud detection and measurement, economic research examining the decision-making contexts which engender fraudulent behaviour (i.e., behavioural incentives, market regulation and institutional structures) may offer

Second authorship is shared equally by Drs Bonanno, Boys and Smith.

†Mariah Dolsen Ehmke (email: Mariah.Ehmke@uwyo.edu) is Associate Professor of Agricultural and Applied Economics, University of Wyoming, 1000 East University Avenue, Department 3354, Laramie, Wyoming, 82072, USA. Alessandro Bonanno is Associate Professor of Agricultural Economics at the Department of Agricultural and Resource Economics, Colorado State University, Clark Building, Room B327, Fort Collins, Colorado, 80524, USA. Kathryn Boys is Assistant Professor at the Department of Agricultural and Resource Economics, North Carolina State University, Nelson Hall 4306, Campus Box 8109, 2801 Founders Drive, Raleigh, North Carolina, 27695, USA. Trenton G. Smith is Associate Professor at the Economics Department, University of Otago, Dunedin 9054, New Zealand.

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additional avenues for food fraud prevention. To date, relatively little applied economic research has considered the regulatory, enforcement, information and other forms of market failure which contribute to fraud within the agri-food sector.

This special issue extends current research to economic analysis of food fraud. In this article, we identify research gaps pertaining to food fraud economics and provide context for articles featured in this special issue. Despite growing fraud prevalence in the global marketplace, applied economists have, for the most part, politely refrained from using the 'f' word while empirically testing for the effects of fraudulent practices and measuring welfare losses from mislabelling, misrepresentation and corruption.

In what follows, we review economics research developments related to food fraud, highlighting several important and illustrative instances of fraud. First, we frame the emergence of food fraud in the broad context of asymmetric information and notorious 'lemons equilibrium'. Then we discuss the role of regulatory, institutional and legal food fraud affecting international trade. We continue discussion of welfare losses and detection costs associated with food fraud. After an overview of primary food fraud types, we conclude discussing future avenues of economic research on food fraud.

2. Asymmetric information, food fraud and food labelling

The lack of a universal fraud definition poses an initial challenge to economic analysis of 'fraud'. The Australian Institute of Criminology defines fraud as a '*. . .category of conduct that involves the use of dishonest or deceitful means to obtain some unjust advantage'*. According to the European Commission's European Anti-Fraud Office, '*Fraud is a deliberate act of deception intended for personal gain or to cause a loss to another part* (European Commission 1995)'. Further muddling the issue, the U.S. Department of Justice (2019) does not provide a fraud definition. Historically, economists considering scarce resource allocation have not been concerned with an 'intent to defraud'. The occurrence of fraud, however, relates closely to asymmetric information. In what follows, we use the word fraud in the broadest sense, pertaining to any situation in which asymmetric information is present.

Consumers' or buyers' ability to evaluate the presence of certain attributes only after having consumed or used the product (i.e., experience attributes), or inability to determine the presence of an attribute even after consumption (i.e., credence attributes), provides sellers with an incentive to commit fraud (Nelson 1970; Darby and Karni 1973). In his seminal article on the problem of asymmetric information, Akerlof (1970) describes a competitive used car market in which the seller, but not the buyer, knows the quality of a given car. Because buyers cannot distinguish between good and bad cars, Akerlof (1970) reasons all used cars must sell for the same price. In other words, if quality claims are unverifiable, we should expect buyers to be sceptical and sellers' claims, fraudulent or not, to be mostly irrelevant.

Further, Akerlof notes adverse selection can arise in any market where trust is essential. In describing the adverse selection problem, Akerlof (1970) anticipated many issues that have occupied economists ever since, including the market collapse now known as the lemons equilibrium, the possibility that government intervention in markets might be required, and scenarios in which private institutions (e.g., proprietary brands) which have market power might behave in ways which reduce adverse selection. Broadly, the economic theory of asymmetric information is compelling in considering food fraud because it describes a widespread aspect of economic activity, and it is important due to the magnitude of potential effects on both consumer welfare and industry profits.

In food markets, standardised label adoption is a widely accepted solution to 'lemons problems' (Caswell and Padberg 1992; Caswell and Mojduszka 1996). Labels and certifications are widely adopted tools to 'correct' asymmetric information problems and transform credence and experience attributes into search attributes (Caswell and Mojduszka 1996; Giannakas 2002; Caswell 2006). However, the credibility of the label, which is in turn associated with the rigor or strictness of the certification process, is crucial to resolving asymmetric information problems (Caswell and Anders 2011).

Food fraud is a greater threat in markets with greater information asymmetries due to ineffective certification and regulation processes. When information concerning product quality is not universally available to market participants, demand will be determined by participants' beliefs about quality. This may lead to more than one equilibrium outcome (i.e., multiple market equilibria exist for consumer segments with different beliefs). Possible equilibrium outcomes increase. Moreover, so-called 'imperfect' labels may be ineffective if they fail to target qualities consumers care about, are too complicated for consumers to understand or are implemented by an institution which consumers do not trust (Teisl and Roe 1998; Roe and Sheldon 2007; Bonroy and Constantatos 2008; Smith *et al.* 2011).

Fraud is rarely analysed in markets characterised by common reputation and 'nested names', where firms simultaneously adopt a private brand and collective label(s) such as labels of Geographic Indication (GIs) (Moschini *et al.* 2008, Menapace & Moschini 2011, Yu *et al.* 2017, Di Fonzo and Russo 2015). In such markets, establishing a collective reputation brand allows for vertical differentiation or, at least, a minimum quality standard.[1] Using nested names instead allows firms to use their private brand or the common label to differentiate products. Markets of products carrying GIs constitute a prime example of 'nested names' food markets. Researchers tend to assume GIs are 'perfect labels', having positive welfare effects and increasing efficiency in quality provision (e.g., Moschini *et al.* 2008; Menapace & Moschini 2011). However, other studies show

[1] Desquilbet and Monier-Dilhan (2015) argue that, if quality is endogenous and consumers value both GI and the sensorial quality, GIs can act as a minimum quality standard instead of a denomination standard.

GI labels' limitations. For example, Grunert and Aachmann (2016) find consumers have 'low to medium' GI label awareness, and such labels may play only a limited role in consumers' decisions. Winfree and McCluskey (2005) show, in a dynamic setting, collective reputation associated with GI may be seen as a common resource. Without traceability, firms producing experience goods have incentives to market products with suboptimal quality. Such findings do not imply frauds will necessarily occur in markets characterised by collective reputation or nested names. However, some suggest that without strict regulation, mislabelling fraud is possible.[2] Di Fonzo and Russo (2015) explicitly model GI consortia formation, allowing consortium members to engage in fraud. Notably, these authors find as long as there is a positive probability, frauds go undetected, and if punishment is not perfect, then defecting firms prefer using the consortia label and commit fraud rather than not using the GI.

3. Food fraud and international trade

Fraud opportunities proliferate in markets with many buyers and sellers along supply chains. With a considerable number of brokers and intermediaries, one of the most important determinants of fraud risk in agri-food markets is the number of times food changes hands (Sampson 2017). In globalised agri-food supply chains, ingredients may be sourced and aggregated via complex networks of brokers and distributors who, themselves, could have little knowledge of or accountability for the products they handle (Morehouse *et al.* 2010). While economic incentives are always present, fraud may flourish when products are sourced from or shipped via countries with weak or insufficiently enforced domestic regulations or poorly structured legal systems. The international trade of food products increases fraud potential due to lack of preventative legal strategies, extended supply chains and increased difficulty identifying the source of fraud. As international trade articles in this special issue illustrate (e.g., Muhammad and Countryman 2019; Ferrier 2019), fraud occurs along multiple routes when products cross geopolitical borders.

The international business legal environment exacerbates food fraud complexity. Import-Export Contracts of Sale used in transactions include provisions concerning the remedial action available to participants, applicable laws that govern the contract and an arbitration clause enabling parties to reach an amicable and quick dispute settlements.[3] In a cross-border

[2] For a more thorough discussion of the literature on the economics of collective reputation and nested names the interested reader can refer to (inter alia) Costanigro *et al.* (2012; Costanigro *et al.*, 2012), Saak (2010), Di Fonzo and Russo (2016), Yu *et al* (2017), and the literature cited therein.

[3] Unless subject to mandatory provisions regarding arbitrators in their own territory, parties are otherwise able to select both their arbitrator and rules that will govern the arbitration (Cheskin and Hertell, 2010). Several international arbitral institutions (each with their own rules) are available including: the United Nations Commission on International Trade Law (UNCITRAL), the International Chamber of Commerce (ICC), the International Center for Dispute Resolution (ICDR) and the London Court of International Arbitration (LCIA).

transaction, laws from several jurisdictions may apply. With the exception of laws that regulate public policy matters within a given country (e.g., some environmental regulations and security laws), it is generally accepted that parties engaged in international commercial transaction are free to choose the law that will apply to their agreement (Cheskin and Hertell 2015). In the U.S., a national or state law is typically selected, but parties may choose to abide by other law such as public international law or transnational law (e.g., the United Nations Convention on Contracts for the International Sale of Goods). Parties might also agree that different contract components will be governed by different laws (Cheskin and Hertell 2015).

Prosecuting criminal cases requires joint cooperation among agencies from different countries. For example, Europol and INTERPOL have conducted an annual joint operation since 2011 due in part to the frequent connections between food fraud and organised crime (OPSON) to investigate counterfeit and substandard food products. Most recently this operation was run across 78 countries (including Australia) between December 2018 and April 2019. Investigators checked more than 67,000 shops, markets, airports, seaports and industrial facilities. Over the course of the latest investigation, seizures of more than 16,000 tonnes and 33 million litres of either counterfeit or substandard (which is not necessarily fraudulent) food and beverages were made, and 672 people were arrested or detained (Europol 2019).

Counterfeit foods infringe on intellectual property rights defined under a country's national or, in the case of EU members, European law (Spink *et al.* 2011). The quality of counterfeit or substandard products may also be inferior to legal requirements under national or European standards. In addition, domestic and international criminal law, including the Rome Statute of the International Criminal Court,[4] may also be relevant in cases that result in death or health complications and are justiciable under the principle of reckless endangerment. The United Nations Convention against Corruption may also be relevant in cases where public officials were bribed to conceal food fraud (United Nations General Assembly 2015). The treatment of food fraud cases and related industry stakeholders through arbitration or criminal court settings is ripe for examination through a global political economy lens.

There are a number of channels by which aggregated cross-border transactions involving fraudulent products may have potential impacts on the international trade of agri-food products. Broadly, these channels are categorised as those that can impact the cost of authentic versions of products, costs of and revenue from international trade transactions and the willingness of countries to engage in trade with one another.

[4] The Statue of Rome is a founding treaty of the International Criminal Court and was written to establish a mechanism to deal with the most serious crimes of international concern, namely genocide, crimes against humanity and war crimes.

Food fraud may increase public and private international agri-food trade costs. Increasing food fraud rates increase demand for border inspections and testing and related domestic food safety assurance costs. In major developed country markets, border inspection procedures are moving from response-focused to prevention-focused models. While specific procedures vary by country, practices for sampling and inspecting imported goods may be based on product risk categorisation or previous product compliance history, which may be nil for new imports into new markets (Sertkaya *et al.* 2013). In the U.S., for example, Buzby *et al.* (2008) note the U.S. Food and Drug Administration (FDA) inspects approximately one per cent of imported food shipments at a point of entry. Producers who repeatedly violate U.S. regulations or whose violations pose human, animal or plant health risk (sanitary and phytosanitary (SPS) concerns), may be subject to a higher level of surveillance. In these cases, products may be subject to a more in-depth inspection.[5] Similarly, in the E.U. the Rapid Alert system for Food and Feed (RASFF) is used by member states[6] to provide market notifications, including border rejections. Details of food and feed import practices employed by several mature importing markets are described by the Institute of Medicine (IOM) and National Research Council (NRC) (2010) and Sertkaya *et al.* (2013).

In addition, fraud raises international buyers and sellers trade costs. In many countries, variable costs associated with border inspection, testing and product quarantine are either completely (e.g., Australia) or partially (e.g., U.S.) passed along to the importer of record (Australian Government Department of Agriculture and Water Resources 2015, USDA-APHIS 2014). In instances where (potential) fraudulent food product poses a human or animal health risk, imported products from a manufacturing firm, in a product category or from a country perceived to have higher potential of food safety risk due to fraud (or other reasons) may face additional testing and border delays. This elevates trade costs. In addition, costs of introducing additional security measures to address international supply chain vulnerabilities, cargo insurance costs and risks associated with supply chain integrity may climb for products or settings particularly susceptible to fraud.[7] These

[5] In such cases, an alert is issued and a 'Detention Without Physical Evidence' or an 'Automatic Detention' system is activated.

[6] RASFF member states are the EU-28, European Economic Area (EEA) member countries (which is composed of EU countries and Iceland, Liechtenstein and Norway) and Switzerland.

[7] By way of example, product liability insurance is commonly used and product contamination insurance is increasingly used in the U.S. market. Product liability insurance is third-party insurance, which covers losses incurred by a producer related to its liability to injured consumers or indemnification of its suppliers for such liability. Product contamination insurance is first-party insurance, which covers losses incurred by a producer related to implementing a product recall, suffering business interruption and sales losses due to brand damage. Both of these forms of insurance relieve producers of the risk of potentially bankrupting losses that could result from a foodborne illness outbreak and transfer that risk to an insurance company in exchange for a predictable premium.

additional trade costs may further drive a wedge between fraudulent and non-fraudulent product prices.

4. Consumer and societal food fraud costs

There have been relatively few attempts to quantify the societal welfare effects of food fraud. One challenge in measuring consumers' welfare losses due to fraud is that fraud affects different consumers differently. Drawing from work by Bonanno *et al*. (2015), the current paper by Bimbo *et al*. (2019) illustrates an empirical model which simulates welfare losses due to labelling fraud and the overpayment of a premium price. It then assesses the tradeoffs between profitability, lack of image and fines in determining the incentives of a producer to commit labelling fraud. However, a limitation of their estimated model is that they consider consumers' heterogeneity in price responsiveness but not a consumer evaluation of the attribute subject to fraud.

Foster and Just (1989) were early to explore consumer heterogeneity and resulting welfare loss variations. They propose an empirical framework to assess the welfare effects of a food product contamination (milk contaminated with the pesticide Heptachlor in Hawaii), explicitly including consumer uncertainty. Risk perception heterogeneity affects consumer reaction to fraud. In the case of adulteration, a consumer's risk perception depends on the degree of physical hardship and financial loss they may incur from an incident (Liu *et al*. 2014; Charlebois *et al*. 2016). According to Charlebois *et al*. (2016), implications for consumers of adulteration and other fraud depends on how permanently or temporarily occurrences are in the consumers mind. This suggests a consumer's perception of risk is not stable, but rather fluctuates over time. It is unclear, however, how this potential dynamic affects consumer welfare when food fraud (or possible food fraud) emerges. Additionally, even though, in principle, all consumers should benefit from decreases in fraud, demand for technology or information signalling the absence of fraud may differ across consumers. Charlebois *et al*. (2016) examined consumer propensity to verify product origin and quality using labels and authentication technology (e.g., DNA-based tags, infrared light technologies and molecular markers) in Austria. They find consumers with the greatest level of distrust in the food industry, and food industry regulators are most likely to take advantage of traceability and tampering information and technology.

Consumers' ability to detect quality differences between low-quality and high-quality producers or products through labels, traceability information or other quality signals and detection tools also affects producer welfare. In scenarios where high-quality producers are unable to reliably differentiate their product or in settings where high levels of mislabelling, counterfeit or diversion occur, high-quality (cost) producers may be driven from the market and low-quality producers may gain economic advantage. When quality of the higher quality product can be ascertained by consumers at least part of

the time (e.g., with partial or incomplete regulation), high-quality producers are more likely to remain in the market. In this instance, however, the low-quality producer may take advantage of parallel market opportunities or consumers who are less aware of quality differences. Additionally, the emergence of isolated food fraud scandals may result in widespread losses and changes in consumer behaviour that may affect an entire industry. In the case of the U.K. horsemeat scandal, for example, Yamoah and Yawson (2014) find a decrease in retail sales of beef-based foods, especially for health risk-averse consumers. In the aftermath of this scandal, Agnoli *et al.* (2016) found European consumers have strong preferences for ready-to-eat beef products made with domestic beef, and a positive willingness to pay for products with enhanced food safety standards.

Food fraud detection is costly and likely to increase the cost of fraud susceptible products in the long run. Manufacturers need to introduce measures to demonstrate product authenticity, improve supply chain security and show compliance with product and process standards. For example, food manufacturers may protect their products and packaging from counterfeits through overt and covert product authentication methods, continuously updating products and packaging, maintaining anti-counterfeit investigation teams or developing consumer education programs and initiatives (Sangani 2010; Lefebvre *et al.* 2011; Wilcock and Boys 2014). Emerging scientific approaches are focused on assessing products authenticity. For example, polymerase chain reaction (PCR) techniques are used to identify meat species in pet foods and DNA barcoding to identify mislabelled fish products (Di Pinto *et al.* 2015; Okuma & Hellberg 2015). The expense of such verification methods increases authenticated product costs relative to fraudulent products. There are significant welfare implications, especially for lower income consumers or those in lower income countries, as such costs decrease legitimate producers' costs and increase the cost of non-fraudulent food for consumers.

Given high detection and enforcement costs, Spink *et al.* (2017) argue that instead of focusing on mitigation strategies, establishing a 'preventive' approach is a more effective way to counteract food fraud (in line with preventive measures used to ensure food safety). This may also limit negative consequences of fraud. To do so, however, it is important to understand frauds' incentives. Hirschauer and Zwoll (2008) use a principal-agent model to determine optimal fine levels or fines that will offset a firm's illegal profits from frauds. Others have investigated factors affecting organic farmers' non-compliance decisions (e.g., Lippert *et al.* 2014; Gambelli *et al.* 2014) and factors affecting farmers' tolerance of unethical behaviour (Hendrickson and James 2005, 2008).

Monitoring is costly. Yet, research on collective reputation labels indicates peer-monitoring within industry firms producing the legitimate product, or intra-industry punishment schemes, should be larger to ensure food labelling fraud deterrence. Saak (2012) shows that if peer monitoring efforts are (1)

perfect and (2) information is disseminated quickly, then (3) gains from deviating are smaller compared to premiums, and (4) consumers have precise information about quality. This increases incentives to engage in collective reputation and not to defect – even with imperfect public monitoring. This result is similar to Di Fonzo and Russo's (2015) conclusion that a command and control approach is not an efficient strategy to promote geographic indication (GI) and enforce higher quality.

5. The many faces of fraud: mislabelling, adulteration, tampering and diversion

The voluntary practice of misrepresenting product attributes by mislabelling the product (labelling fraud) is the most common type of fraud in agricultural and food markets (European Parliament 2013; Charlebois *et al*. 2016; EU Food Fraud Network 2016; Whitworth 2017). The U.S. Department of Agriculture (USDA) discovered over one hundred fraudulent organic certifications in the U.S. since 2006 (USDA 2018). In the EU, approximately nine per cent of all food products carrying protected GI labels are fraudulent (EUIPO 2016). Food sectors which are particularly affected by labelling fraud include extra-virgin olive oil, honey and seafood/fisheries (Moore *et al*. 2012, Aries *et al*. 2016, FAO 2018). In spite of its pervasiveness, studies examining labelling fraud of food products are limited in both number and scope.[8]

In a perfect world, a prohibition on false claims would be sufficient to eliminate labelling fraud. In reality, this is not the case. In this special issue, Meerza *et al*. (2019) show labelling and food integrity policy development needs to include economic analysis of societal welfare consequences from food fraud. Before the organic standard was established, for instance, the word 'organic' had varied meanings. Producers marketed products as 'natural' or 'pesticide free' without legal restrictions. As a result, consumers were left to sort through competing claims. Stivers (2006, 2009) shows the need for (and number of) quality standards depends on the differential cost of producing high-quality products and value consumers attach to said quality.

Even without problems stemming from language ambiguity, history demonstrates the lemons situations persist and firms exploit consumer ignorance. When the causal role of trans-fats in heart disease became conventional wisdom in the early 1990s, products without trans-fats had an opportunity to trumpet this fact. Some U.S. food manufacturers did, but many more did not. At the time, an astute consumer could check product ingredients for the phrase 'partially hydrogenated' (an indication that trans-fats are present), giving producers incentive to remove these ingredients. But reformulation is costly, and the food manufacturing industry fought against a mandatory label for years. In 2003, the U.S. announced that, beginning in 2006, standard nutrition labels would include the amount of trans-fats in products. The food industry pre-emptively reformulated products, and trans-

[8] See Bimbo *et al*. (2019), for a review.

fats were largely removed from the food supply by 2006 (Unnevehr and Jagmanaite 2008). The most generous interpretation of these events is that companies maintained the lemons' equilibrium, in the absence of a mandatory label, as long as consumer information costs were sufficiently high.

Also, labels based on continuous quantitative quality measures can be detrimental to sustained cooperation. A notable example of a failed cooperative was the 'Smart Choice' label initiated by one of the largest U.S. sellers of processed food industry groups. The consortium included Kraft Foods, ConAgra, Kellogg and PepsiCo. It funded the Smart Choice initiative via a subscription model. They assembled a blue-ribbon panel of prominent nutrition experts to provide program oversight. To qualify for the label, products had to meet category-specific minimum levels of beneficial nutrients with limited quantities of fat, sugar and sodium. More than 2,000 products initially qualified, emblazoned with the logo. But soon, breakfast cereal manufacturers threatened to leave the program (taking their fees with them) unless there was an increase in the maximum sugar limit. The consortium raised the sugar limit to the point that popular but less healthy cereals (e.g., Fruit Loops and Lucky Charms) qualified as Smart Choice. Subsequently, the nutrition experts resigned *en masse* and the consortium collapsed (MacVean 2009).

Adulteration is often considered the original food fraud. Frauds adulterate food through food product imitation or counterfeit. Adulteration also includes substituting inferior for premium ingredients in processing or through the supply chain to earn superior profits. Common examples of adulteration include watering down milk, creating pasta with alternative wheat varieties, using cheap fruits in fruit juices (e.g., substituting grape for cranberry) or using dust or sawdust in spices or spice mixes (Sumar and Boville 1995). Despite its long-standing prevalence, there is limited economic analysis of adulterations' consumer *welfare* impacts compared to other types of food fraud. One adulteration case that has received attention is the 2013 horsemeat scandal in the U.K. The incident shocked and enraged consumers.[9] Consumer research following this incidence indicates the scandal not only shaped consumer perceptions of food fraud, but also consumers' priors and food industry expectations. These elements influence the degree of blame consumers assign to a particular food supply chain actor (Charlebois *et al.* 2016).

While the horsemeat scandal engulfed European food society, China suffered serious food adulteration incidents. In 2013, the Guangzhou food and drug administration uncovered cadmium coated rice in that province. Two years later, 200 rice plants closed after an adulteration event in

[9] This event created reams of research opportunities. One of the most cited policy papers on food fraud prevention, the Elliott Report (2014), followed this scandal and now guides the U.K.'s policy on food fraud prevention.

Heilongjiang province. Increasingly, Chinese consumers worry about illegal additives to, and toxic waste contamination of, their grain. Interviews with Chinese consumers reveal uncertainty regarding rice quality varies by consumer location (e.g., urban or rural), consumer product knowledge, age, trust in government regulatory agencies, trust in media and social media use. Consumers are generally anxious about grain consumption but feel powerless (Zhu *et al*. 2017).

One possible avenue to reduce fraud in China and around the world is facilitating consumer's ability to detect product tampering. Consumer advocacy groups encourage packaging and labelling adjustments that enable consumers to self-authenticate purchases. Regulators are interested in packaging that not only indicates whether tampering happened, but at which production stage it occurred. Despite calls for tamper-proof food packaging, food companies have yet to deliver broad implementation, especially in developing countries (Spink *et al*. 2011). For example, Thai consumers rank tamper resistance and ease of opening as their top packaging concerns (Jinkarn and Suwannaporn 2014). Yet, food firm management often overlooks packaging in the production process or resists spending money to improve it. When firms do look to address the problem, technology challenges often stand in their way.

As articles by both Ferrier (2019) and Jones Ritten *et al*. (2019) illustrate, honey is historically a fraud target, especially when used as a processed food ingredient. This is due, at least in part, to its overall homogenous appearance and low consumer knowledge of honey quality. Recently, Western nations have inadvertently prompted international honey diversion. For example, as the U.S. enacted restrictive trade policies on the importation of Chinese honey to the U.S., they effectively created incentives for companies to divert Chinese honey in global markets.

6. Food fraud: an economic research agenda

While existing research on food fraud provides a useful foundation for economic researchers and policy makers, there is vast opportunity for economic work in this area. Economic analysis is needed to explore the spillover effects of food fraud on other products and among different market areas, how consumer welfare is affected by additional types of fraud (e.g., over-run, theft and counterfeit) and the magnitude of societal losses when multiple types of fraud occur.

Food fraud may affect international trade through changing relative prices, affecting buyer demand and risk aversion, and additional non-tariff trade barriers. The potential for spillover effects of fraud cases to other products and geographic market areas or the possible transshipment of products to avoid tariffs also impacts international trade. These potential impacts, however, are difficult to quantify. It also remains an open empirical question as to what extent, if any, the number of cases or the relative prevalence of fraud impacts

international trade patterns. When there is complete and enforceable market regulation, or consumers can clearly ascertain product quality differences (e.g., with complete labelling and traceability), then high- and low-quality producers are likely to have transparent market interactions across marketing channels. Research findings suggest consumers' ability to perceive product quality differences affect their susceptibility to diversion. Extending the literature on asymmetric information, this suggests consumers may vary in the benefits they generate from clearer product traceability and information.

Labelling is one of the primary routes food producers may use to defraud consumers. Consumer fraud, though, goes beyond the label. Even for food without value-added and credence claims, consumers may experience significant welfare decline when food is adulterated, tampered with (in wholesale or retail environments) or food is diverted. It may be, for example, that consumers' concerns related to diversion have commonality with their concerns related to other types of black market fraud, including over-run, theft and counterfeit goods. Few studies take on multiple dimensions of known or potential food fraud. Those that do show consumers may assess different food fraud threats differently depending on a range of psychometric and environmental factors (e.g., Liu *et al.* 2014). Such studies offer an opportunity for comparison of the welfare implications for consumers of fraud in food production, processing and retailing environments.

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