

“Brexit: Why did the ‘chlorinated chicken’ cross the pond?”*

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Abstract

The analysis presented in this paper suggests that a credence good such as non-chlorinated chicken could be supplied by firms, either voluntarily or due to pressure from activists. If UK consumers have a high willingness to pay for non-chlorinated chicken, it may be supplied at the same time as imported chlorinated chicken. The level of any private standard for UK poultry processing will be determined by the costs of supplying non-chlorinated chicken, the extent of competition in the UK poultry processing sector, and the nature of the UK’s post-Brexit trading arrangements.

Keywords: credence goods, food safety standards, clubs, activists

JEL Codes: D82, L5, L15, Q17, Q18

1. Introduction

Several important economic issues have been thrown up since the UK's electorate voted in June 2016 to leave the European Union (EU), with most of the economic and political debate focusing on the nature and impact of the UK's future trading arrangements with the EU (HM Government, 2018; Colantone and Stanig, 2018). In the context of the broad debate about Brexit, considerable public concern has also been expressed about what will happen to the UK's food safety standards if and when it eventually exits the EU (*The Observer*, January 29 2017). Notably, there has been discussion of the possibility that post-Brexit, there could be divergence between the EU's food safety regime, and any rules that the UK chooses to adopt if it seeks to negotiate new free trade agreements (FTAs) with third countries (*UK Trade Forum*, September 20, 2017). Public outcry over the latter possibility initially intensified when Liam Fox, the UK International Trade Secretary, while discussing a potential FTA with the United States, "mocked concerns about the import of chlorine washed chickens in the UK after Brexit, and insisted it is just a 'detail' of trade negotiations with the US" (*The Telegraph*, July 24, 2017). Fox has continued to make controversial statements about chlorinated chicken that have caught the attention of both the British media and anti-Brexit groups. Most recently, he claimed,

"...there's been no argument about food safety on chlorine washed chicken – it's been an argument about animal welfare..." (*The Independent*, May 15, 2019).

Woody Johnson the US ambassador to the UK also threw fuel on this particular fire by castigating the public discussion over post-Brexit food standards,

"...You have been presented with a false choice. Either stick to EU directives, or find yourselves flooded with American food of the lowest quality. Inflammatory and misleading terms like 'chlorinated chicken' and hormone beef are deployed to cast American farming in the worst possible light. It is time the myths are called out for what they really are. A smear campaign from people with their own protectionist agenda." (*The Telegraph*, March 2, 2019)

George Eustace, former UK agriculture minister pushed back by noting,

“Agriculture in the US remains quite backward in many respects... Whereas we have a ‘farm to fork’ approach to managing disease and contamination risk throughout the supply chain through good husbandry, the US is more inclined to simply treat contamination of its meat at the end with a chlorine or similar wash.” (*The Guardian*, March 6, 2019)

The substantive issue here is the difference between EU and US animal welfare and food safety standards as they relate to production of chicken. In the EU, standards are based on a perceived interdependence between animal welfare and food safety: specifically, the EU mandates a minimum amount of space, lighting and ventilation for poultry rearing houses, which raises EU production costs but reduces the risk of disease and contamination in the flock. By contrast, US poultry production is relatively unregulated, flocks being kept in much higher densities with a higher incidence of infection (Dawson, *The Conversation*, August 2, 2017). EU standards on flock density are also associated with application of different post-slaughter standards compared to the US: EU poultry processors are only allowed to use cold air and water to decontaminate poultry carcasses, while US processors are allowed to wash them in a strong chlorine solution designed to kill bacteria such as *Salmonella* and *Campylobacter*.

Public concern over standards for poultry production is just the endpoint of a long-running dispute over the issue between the EU and US. The dispute began in 1997 when the EU first banned the use of pathogen reduction treatments (PRTs) in poultry processing. PRTs are antimicrobial rinses, including chlorine dioxide, acidified sodium chlorite, trisodium phosphate, and peroxacetic acid (Millstone, Lang and Marsden, 2017). PRTs have been approved for use in US poultry processing by both the US Department of Agriculture (USDA) and the US Food and Drug Administration (FDA). After slaughter and processing, poultry are applied with PRTs either as a spray or wash, federal regulations determining PRT concentration levels (Congressional Research Service, 2017).

In 2002, the US sought approval for four PRTs used on poultry to be exported to the EU. Following this request, the European Food Safety Agency (EFSA) published a key opinion on PRT use in December 2005, EFSA concluded that the four PRTs “would be of no safety concern” (EFSA, 2005, p. 20). Following this and other published opinions on PRT use (EFSA, 2008; European Commission, 2008), the European Commission (EC) committed in May 2008 to regulatory change that would allow PRT-treated poultry to be imported by or be produced in EU member states. However, the proposal was rejected by the European Parliament in June 2008, and subsequently by the EU Agricultural and Fisheries Council in December 2008 (Congressional Research Service, 2017).

Given the almost total loss of EU market share by US poultry exporters, and the EU’s subsequent failure to approve PRT-use, the US sought resolution through the World Trade Organization (WTO) in January 2009 (WTO, DS389, October 2009). The US position was that the EU’s ban on PRTs in poultry processing was inconsistent with its World Trade Organization (WTO) obligations under both the Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) agreements. Following initial consultations between US and EU, the US Trade Representative (USTR) asked the WTO to establish a dispute settlement panel in October 2009, the panel being established in November 2009.

Although the case filed at the WTO has never actually moved forward, the issue of food safety standards and trade has clearly not gone away. It gained considerable media attention during negotiations between the EU and US over the proposed Transatlantic Trade and Investment Partnership (TTIP) (*The Washington Post*, December 4, 2014), with non-governmental organizations (NGOs) such as Friends of the Earth Europe expressing the view that “in Europe there is definitely disgust about chlorinated chicken” (NPR, September 30, 2014). In the context

of Brexit, Commerce Secretary Wilbur Ross has publicly stated that any trade deal between the US and the UK will be contingent on the latter scrapping EU rules on chlorine-washed chicken imports (*The Guardian*, November 6, 2017). This view has subsequently become the official negotiating position of the USTR's office when it published a summary of its objectives in negotiating a future FTA with the UK post-Brexit (USTR, February 2019). The USTR makes it very clear that in any agreement, it wants to see the removal of non-tariff barriers to trade as they relate to sanitary and phytosanitary standards applied in the food and agricultural sector (*The Guardian*, March 1, 2019).

If in some future FTA, the UK allows the import of chlorinated chicken from the US, and assuming that it does not implement mandatory process labeling, the market for chicken could go from one currently where consumers know with certainty that the product is not chlorine-washed, to one where chicken is regarded as a *credence* good. Irrespective of whether chlorine-washing of chicken is safe or not, a majority of UK consumers have signaled opposition to its introduction into the market (*The Guardian*, May 26, 2018; *The Grocer*, December 3, 2018).¹ Surveys also suggest that if chlorine-washed chicken is allowed into the UK after Brexit, a majority of consumers will pay more attention to labeling and production methods, while the British Poultry Council has expressed concern that such imports will compromise existing standards for poultry production, and that British firms would seek to maintain their current reputation for high-quality production (*The Grocer*, December 3, 2018)

Credence goods have been analyzed extensively in the agricultural economics literature, the bulk of the research focusing on public certification mechanisms (Sheldon, 2017). However, less

¹ Discussion over the safety of PRT use in poultry processing is ongoing (Millstone, Lang and Marsden, 2017; The Adam Smith Institute, 2017). For example, an article by researchers at the University of Southampton (Highmore *et al.*, 2018) indicating that chlorine washing of contaminated spinach did not kill *salmonella* was widely discussed in the British media (*The Guardian*, May 26, 2018).

attention has been paid to the possibility that if private certification is permitted, processing firms might act to raise food quality either to establish a reputation for corporate social responsibility and/or because they come under external pressure from NGOs (Baron, 2009a).

Adapting a model originally due to Baron (2009b; 2011), this paper focuses on the credence good outcome where a government allows a “low-quality” good (chlorine-washed chicken) to be sold in a market where previously only a “high-quality” good (non-chlorine-washed chicken) was sold. Specifically, the analysis focuses on the extent to which the high-quality credence good will be supplied by the private market, in the absence of any government regulation, and the role that NGOs might play in ensuring provision of the high-quality good.

The structure of the model consists of UK poultry processors producing either low or high-quality goods, a continuum of consumers uniformly distributed in terms of their willingness to pay for the high-quality credence good, and an activist(s) (NGO) applying social pressure to these firms concerning their processing methods. In the absence of mandated public certification of the credence good, poultry processors can form a club to set and certify a production standard for the high-quality good. Compared to poultry processors producing the low-quality good, firms joining the club incur convex fixed costs and higher marginal costs in meeting the standard. Once the standard is set, poultry processors producing the credence good compete in a Nash-Cournot game, while low-quality goods are produced in a market where processors competitively price at marginal cost. The activist(s) can choose to target the high-quality processors, the latter forming a coalition to contest the campaign.

From this model several key propositions can be derived: (i) a credence standard allows for vertical product differentiation, where consumers with a high willingness to pay for credence goods purchase from processors in the club, while consumers with a low willingness to pay

purchase the low-quality good. Compared to a situation where the low-quality good is banned, this has the potential to raise aggregate consumer surplus; (ii) the price of the credence good is increasing in the standard chosen by the club; (iii) profits of processors producing the high-quality good are increasing in the standard; (iv) the choice of standard by the club is increasing in the number of consumers in the market and the upper bound on willingness to pay for high-quality, and decreasing in the marginal and fixed costs of meeting the standard, the proportion of consumers not willing to pay for the credence good, and the number of processing firms in the club; and, (v) the probability of an activist successfully targeting processing firms in the club is decreasing in the club standard, the size of the club, and the costs of meeting the standard, and is increasing in the brand equity of processing firms in the club, the size of the market, and consumer willingness to pay for high-quality.

These results have important implications in the context of the industry case used to motivate the paper. Given the surveys of UK consumers of chicken, and the views of poultry producers, it would seem that in the absence of the current EU standards preventing imports of chlorine-washed chicken, private standards could be implemented, their level depending particularly on the UK's poultry processing market structure post-Brexit. The number of processors with the potential to sell non-chlorine-washed chicken in the UK will depend on trading arrangements the UK eventually negotiates with the EU. If the UK leaves the EU customs union to trade by WTO rules, setting a bound tariff on imported chicken, this has the potential to decrease competition, allowing a club to set higher standards for production of the credence good, and minimizing the chances of it being targeted by an activist. This has to be weighed against the possibility that access for UK poultry to the EU will be limited post-Brexit, thereby reducing the number of consumers

willing to pay a high price for the credence good, resulting in the club setting a lower standard, opening it up to being targeted by an activist(s).

The remainder of this paper is organized as follows. In section 2, the basic economics of credence goods is outlined, drawing on an earlier review (Sheldon, 2017). This is followed in Section 3 by an outline of the model of which draws extensively on Baron (2009b; 2011), along with key propositions that can be drawn concerning the private supply of non-chlorinated chicken and the role of activists in pushing for higher credence standards. In Section 4, some observations are made concerning the implications of Brexit for UK standards and trade in poultry, while in Section 5, the paper is summarized and some concluding remarks are made.

2. The Economics of Credence Goods

Sexton (2013) notes that there has been a significant increase in demand over recent decades for provision of a range of attributes in food products, many of which cannot be verified either *ex ante* or *ex post* by consumers. These attributes, which are typically interpreted as representing higher-quality products, reflect a range of consumer preferences for food and related products that, for example, meet dietary requirements (low sodium), cover food safety (pesticide residues) and ethical production concerns (animal welfare), satisfy the right-to-know about (genetic modification), and location of (geographic indicators) food production methods, contribute to resolving known externalities associated with food production (shade-grown coffee), and marketing arrangements that promote better trading conditions for marginalized producers in developing countries (fair trade). Food products containing these types of attribute, and which create a severe asymmetric information problem, are part of a broader class of goods known as credence goods.

In his original classification of goods, Nelson (1970) introduced the concept of search and experience goods to the economics lexicon. The former are goods where consumers are able to establish quality *ex ante* through search, the latter are goods where consumers, are only able to establish quality *ex post*. In the case of experience goods, asymmetric information may result in market failure: absent credible signaling by firms or the offer of quality guarantees, consumers expect to be cheated if firms make claims of high-quality, only low-quality goods being supplied in equilibrium, i.e., a market for lemons (Akerlof, 1970). An extensive literature has evolved to analyze circumstances under which experience goods are supplied in equilibrium, seminal articles being Klein and Leffler (1981), Shapiro (1983), Allen (1984), Riordan (1986) and Bagwell and Riordan (1991), focusing on mechanisms such as credible reputation-building, price signaling and repeat purchase, and the role of informed consumers.

Darby and Karni (1973) added credence goods to Nelson's (1970) classification, spawning a literature extensively reviewed by Dulleck and Kerschbamer (2006) who define credence goods as:

“...a situation where an expert knows more about the type of good or service the consumer needs than the consumer himself. The expert seller is able to identify the quality that fits a customer's need best by performing a diagnosis. He can then provide the right quality and charge for it, or he can exploit the informational asymmetry by defrauding the consumer...” (p.5)

This type of information asymmetry gives rise to two specific market inefficiencies: over (under) treatment, where the consumer requires a complex (simple) treatment but instead receives a simple (complex) treatment; and over-charging where a consumer receives a simple treatment but is instead charged for a complex treatment. Dulleck and Kerschbamer (2006) list three conditions under which market mechanisms will discipline experts from acting fraudulently: (i) expert sellers face a set of homogeneous consumers; (ii) there are economies of scope between diagnosis and

treatment, consumers proceeding with the recommended treatment after diagnosis; (iii) treatment is verifiable *ex post* and/or liability rules exist to protect consumers from receiving simple treatment when complex treatment is required.

Dulleck and Kerschbamer (2006) show that if conditions (i) to (iii) do hold, credence goods are provided efficiently, markets solving the problem of fraudulent experts at no cost. Specifically, in equilibrium, each expert posts and charges prices such that the markup for the complex treatment is lower than that for the simple treatment. Verifiability prevents overcharging, i.e., the expert cannot claim complex treatment has been provided when in fact simple treatment was provided; liability prevents under-treatment, i.e., the expert cannot provide simple treatment when the consumer needs complex treatment; the incentive to over-treat is taken care of by the fact that price-cost margins are higher for simple treatment.

If consumers cannot observe and verify the type of treatment they receive, and are unable to punish the expert if they establish *ex post* that they were under-treated, experts have an incentive to act fraudulently and the market for credence goods can even break down, i.e., an expert provides low-quality and charges for high-quality (Akerlof, 1970). Dulleck and Kerschbamer (2006) suggest that a legal rule could be put in place requiring that experts be held liable for supplying inappropriate treatment, but proving liability *ex post* is potentially difficult. Therefore, if punishment of fraudulent experts is ruled out, and reputation-building by experts does not work, then either complete lack of verifiability of treatment or lack of technical expertise on the part of consumers to establish verifiability, will result in fraudulent behavior by experts.

It is precisely the latter possibility that led Caswell and Mojduszka (1996) to introduce credence goods into analysis of food attributes such as safety and nutrition where the typical consumer is simply unable to verify claimed quality, i.e., it is impractical for them to test for say

the protein-content of food or contamination from food-borne pathogens such as *E. coli*. The proposed solution for this market failure is either government mandated labeling of credence attributes or circumscription of voluntarily-supplied information in combination with third-party certification.

With increased presence of credence goods in the food sector, a body of literature has evolved focusing on analyzing their market and welfare-economic impact, including, *inter alia*, e.g., Caswell and Mojduszka (1996), Marette, Crespi and Schiavina (1999), Segerson (1999), McCluskey (2000), Zago and Pick (2004), Roe and Sheldon (2007), and Bonroy and Lemarié (2012).² The analysis presented has focused almost exclusively on the treatment stage of credence goods and how third-party-certification and labeling may be used to ensure consumers are not cheated on claimed food product quality. In other words, consumers are assumed to have full knowledge in forming their preferences about quality (the diagnosis is correct), but they are unable to verify quality both before and after consumption (they may get the wrong treatment). This of course ignores the possibility that either firms or other agents may either defraud or deliberately mislead consumers because the latter have insufficient information to judge whether they needed the claimed quality in the first place.

Virtually all agricultural economics analysis focuses on resolution of the lemons problem via labeling and third-party certification, but little attention has been paid to the fact that NGOs, often acting as self-proclaimed experts, have become increasingly active with respect to provision of credence attributes (Baron, 2009a; 2011). In the case of food credence attributes, probably the best-known example is the interaction between the tuna-industry, the US government, and environmental NGOs such as Earth Island Institute, Greenpeace and the Environmental Defense

² See also detailed surveys by Kiesel, McCluskey, and Villas-Boas (2011); Roe, Teisl and Deans (2014); Bonroy and Constantos (2015); and Sheldon (2017).

Fund concerning protection of dolphins whose population was declining, and the eventual use of certification of a credence attribute through application of the “dolphin-friendly” label (Körber, 1998; Wright, 2000; Baird and Quastel, 2011; Cezar, 2018).

In terms of the extant literature on the role of NGOs in the provision of credence goods, several key results have been derived (Baron, 2011). For example, Feddersen and Gilligan (2001) examine the impact of an information-supplying activist on outcomes in a credence good market where consumers care about the operating practices of firms operating in a duopoly. Their model assumes that activists randomly monitor the specific operating characteristics of one firm, where these are either good or bad, neither being observable to consumers. Through monitoring, activists learn the quality-choice of that firm and then signal that knowledge to consumers who then make their purchasing decision. Activists can support an equilibrium where at least one firm supplies the high-quality good, even though consumers cannot observe quality even after consumption. In addition, depending on the degree of substitutability between goods, activists can support equilibria where either both firms supply high-quality, or low and high-quality goods are supplied. Therefore, activists may improve the workings of a credence goods market.

NGOs may also operate in a setting where government is involved in standard-setting. Heyes and Maxwell (2004) examine the impact of an NGO in a competitive market where government sets a mandatory minimum standard and the NGO can confer a label on firms that voluntarily conform to their standard. Without third-party certification, only the low-quality good is supplied, the latter surviving in equilibrium if an NGO sets a voluntary standard. By comparison, a mandatory minimum standard ensures only a single quality can survive in equilibrium. It is shown that the voluntary label is more attractive to firms than the minimum standard, average quality being higher under the minimum standard, although it is ambiguous which instrument is socially

optimal. Given this result, Heyes and Maxwell (2004) show that a minimum standard is optimal when combined with a voluntary standard set by the NGO.

In examining the influence of NGOs in credence good markets, the presumption of Feddersen and Gilligan (2001) is that firms passively react to activist behavior, while in Heyes and Maxwell (2004) interaction between firms and NGOs affects the extent to which firms will resist standards set by government. This, however ignores the possibility that firms may actually choose to supply credence goods due to some sense of corporate social responsibility (Baron, 2001; Besley and Ghatak, 2007; Siegel and Vitaliano, 2007), i.e., firms engage in a production activity that goes beyond what is required by law.

Baron (2009a) develops an approach to this possibility accounting for corporate social performance – the private provision of public goods, motivated either by a sense of moral duty or self-interest on the part of firms, and which may be either voluntary or a response to external influence. The latter could come from either “public politics” in the form of government regulation (Maxwell, Lyon and Hackett, 2000), or from “private politics”, where private parties such as NGOs, funded by private citizens, seek to influence other private parties such as firms (Baron, 2003; Baron and Diermeir, 2007).³

Baron (2009a) assumes a set up where there is a continuum of citizens, two firms and an activist. Citizens make both consumption and investment decisions, and may also contribute to the activist. One firm is morally motivated, mitigating an externality *ex ante*, even if this does not maximize its market value, i.e., the costs of moral management are not necessarily fully offset in either the product or capital market – if it were, then all firms would act morally. A second firm

³ From a philosophical standpoint, this distinction has its roots in the Hobbesian view of the world where a state, Leviathan, is necessary to provide social order (Hobbes, 1968) versus a world where citizens voluntarily provide social order (Nozick, 1974). See Baron (2003) for further discussion.

is self-interested, and will only mitigate an externality in order to maximize its market value. The activist prefers greater mitigation of the externality than the morally required response, as they care about any remaining harm being borne by citizens. The model generates an equilibrium for the product market, the market for social pressure, and the capital market, the latter pricing moral management and corporate social performance.

Focusing on the product market, both firms produce identical products that can be vertically differentiated under Bertrand-Nash competition through corporate social performance, given that citizens have preferences for reduction in a production externality, a credence attribute. In equilibrium, the morally managed firm produces the higher-quality good at a higher price for citizens who have a high valuation of corporate social performance, while the self-interested firm sells a lower-quality good to consumers with a low valuation of corporate social performance. Whether or not the morally managed firm is more profitable depends on the difference in marginal costs of low and high-quality production and the price premium, and whether or not a majority of citizens have a preference for corporate social performance.

Interestingly, Baron (2009a) is able to rationalize why a firm such as Starbucks, which had already established a reputation for corporate social responsibility in the 1990s, were threatened with a boycott in 2000 by the NGO, Global Exchange, if they did not sell and promote fair trade coffee (Argenti, 2004). By introducing a parameter measuring whether or not consumers distinguish in the product market between *ex ante* and activist-induced corporate social performance, Baron (2009a) is able to predict who will be targeted by activists. If consumers do make the distinction, a morally managed firm will avoid external pressure only if it has built up a reputational advantage over the self-interested firm. If no distinction is made, morally managed firms become softer targets for activists, and are more likely to be subject to external social

pressure. In other words, a firm exhibiting corporate social responsibility acts as an expert in providing the diagnosis, the level of which may be affected by external pressure from NGOs.

3. A Model of UK Poultry Processing Post-Brexit

Basic Model Description

The model consists of poultry processors, a continuum of chicken consumers, and food activist(s). Poultry processors can supply either low (PRTs used) or high-quality chicken (no PRT-use), the latter being a credence good. Chicken consumers have a preference for high-quality chicken, but with no food safety standards in place, consumers will have to be convinced that they are buying high-quality as opposed to low-quality chicken, i.e., they expect to be defrauded over the “level of treatment” they are receiving. In the absence of EU mandatory food standards, poultry processors can establish a club that sets an industry standard for poultry processing (no PRT-use), assures members of the club comply with the standard, and delivers certified information about processing standards for chicken to consumers.⁴ Poultry processors that are not members of the club produce low-quality chicken.

Finally, an activist is assumed to put pressure on firms to introduce high poultry processing standards.⁵ In terms of the credence good problem outlined earlier, the activist focuses on the seeking a higher “level of treatment” than poultry processors provide, but the issue of whether this is the “correct diagnosis” is not considered. For example, the activist may be a coalition of NGOs with different interests in the poultry production chain, one NGO pushing for higher safety

⁴ For example, an organization such as Red Tractor could act as the club for poultry processors. Red Tractor is a UK-based food assurance scheme launched by the National Farmers Union in 2000. <https://www.redtractor.org.uk/choose-site>

⁵ For example, the group Sustain: The Alliance for Better Food and Farming has been active in campaigning to maintain UK poultry processing standards post-Brexit (see Sustain, March 4, 2019).

standards in processing, another seeking higher animal welfare standards in both poultry production and slaughter. While both NGOs affect the “level of treatment”, the “diagnosis” stage is one where it is already agreed that maintaining animal welfare and food safety standards in the poultry production chain are legitimate objectives.

Given this structure, agents play out the following four-stage game: first, the activist demands that firms to set poultry processing standards, and then poultry processors set an industry standard through their club; second, the activist places public pressure on poultry processors; third, targeted poultry processors and the activist play out a contest, the activist campaign being either successful or unsuccessful; and, fourth, given the outcome of the campaign, poultry processors play a Nash-Cournot game in output.

Trade Setting

The institutional setting for the model is one where the UK is neither a member of the EU Single Market nor the EU customs union. This means that: first, the UK is no longer bound by EU food safety standards, including the ban on PRT-use in poultry production; and, second, it is able to negotiate its own FTAs. In terms of its post-Brexit trading relationship with the EU, it is assumed that this either takes the form of a new FTA with the EU or the UK will be trading as a member of the WTO. Depending on the trading arrangement, UK poultry imports (exports) meeting EU food safety standards will either enter (leave) the UK tariff-free or they will enter subject to the UK’s (EU’s) tariff on poultry imports listed in its WTO schedule. In terms of its non-EU trading relationships, a UK-US FTA is in place where UK imports of US poultry are tariff-free and PRT-use in poultry processing is no longer proscribed.⁶ Essentially, the US can export processed

⁶ The implication here is that in negotiating an FTA, the UK accedes to all US demands as laid out by the USTR (2019). This accords with the view that the US has shifted towards “power-based” bargaining in trade negotiations (Mattoo and Staiger, 2019).

poultry to the UK but not the EU, while the UK continues to import (export) poultry from (to) the EU that meets EU food safety standards.⁷

Consumers

Consumers are located on a continuum with mass N . Consumers are of type $w \in [0, \bar{w}]$, consumer types being uniformly distributed over their preferences for credence attributes of processed chicken. Each consumer demands either one or zero units of high-quality chicken, their willingness to pay being given as:

$$u = w_0 + ws \tag{1}$$

where w_0 is willingness to pay for a unit of low-quality chicken which meets a standard s normalized to zero, $s \in [0, \bar{s}]$, \bar{s} being an upper bound on the standard. The low-quality chicken is produced by a competitive poultry processing industry with a world price of p_0 , where $p_0 < w_0$. The price of high-quality chicken $p(s)$ with standard s , is established in the market for the credence good.

Poultry Processors

The poultry processing sector is made up of n identical firms producing high-quality chicken, and a competitive fringe of firms producing low-quality chicken. Poultry processors producing the credence good incur marginal costs:

$$c(s) = c_0 + \gamma s, \gamma \geq 0 \tag{2}$$

where c_0 is the marginal cost of producing low-quality chicken, and γs is the additional marginal cost incurred in producing high-quality chicken, along with any tariffs incurred if the chicken is

⁷ In 2017, the UK imported (exported) 180,975 metric tons (268,523 metric tonnes) of processed poultry from (to) the EU (AHDB, 2018).

traded. In addition, firms producing the high-quality good incur additional fixed costs of meeting the standard and certifying compliance, which are strictly concave:

$$K(s) = \frac{1}{2}ks^2 \quad (3)$$

Processor i producing high-quality chicken earns profits of:

$$\Pi_i(s) = \pi_i(s) - \frac{1}{2}ks^2 \quad (4)$$

where $\pi_i(s) = (p - c_0 - \gamma s)q_i$ is processor i 's operating profit, $p = p(q_s)$ is the price of high-quality chicken, q_i is quantity processed by firm i , and $q_s = \sum_{i=1}^n q_i$ is aggregate quantity of high-quality processed chicken. In the case of low-quality chicken, the world price is $p_0 = c_0$, i.e., US poultry processors make zero profits in equilibrium.

Poultry Processing Equilibrium

A consumer of type w will purchase high-quality chicken as opposed to low-quality chicken if they get greater surplus from doing so:

$$w_0 + ws - p(s) \geq w_0 - p_0 \quad (5)$$

In order to establish demand q_s for high-quality chicken, the consumer indifferent between low and high-quality chicken is denoted as, $w(s) \equiv (p_s - p_0) / s$, so that:

$$q_s = N \left(1 - \frac{w(s)}{\bar{w}} \right) \quad (6)$$

and the inverse demand for high-quality chicken is:

$$p_s = p_0 + s\bar{w} \left(1 - \frac{q_s}{N} \right) \quad (7)$$

Given a food safety standard s , firms processing high-quality chicken maximize operating profit with respect to output:

$$\pi_i(s) = \left[s\bar{w}\left(1 - \frac{q_s}{N}\right) - \gamma s \right] q_i \quad (8)$$

optimal quantity and price respectively being:

$$q_i^*(s) = \frac{N(\bar{w} - \gamma)}{(n+1)\bar{w}} \quad (9)$$

and:

$$p^*(s) = c_0 + \gamma s + \frac{(\bar{w} - \gamma)s}{n+1} \quad (10)$$

Note from (9) that the optimal quantity of high-quality chicken chosen is independent of the standard s , which follows from the fact that the market for low-quality chicken is competitive. From (10), the price of high-quality chicken is increasing in the level of the standard s . In addition, the mark-up of price of high-quality chicken over marginal cost, $c_0 + \gamma s$ depends on both the marginal gain from vertical product differentiation, $(\bar{w} - \gamma)s$ as well as the number of processors n . The operating profit of firm i is:

$$\pi_i^*(s) = \frac{N(\bar{w} - \gamma)^2 s}{(n+1)^2 \bar{w}} \quad (11)$$

the marginal return to the standard being, $\partial \pi_i^*(s) / \partial s = N(\bar{w} - \gamma)^2 / (n+1)^2 \bar{w}$.

Consumers with willingness to pay $w \geq w^*(s)$, purchase high-quality chicken, and consumers with willingness to pay $w \leq w^*(s)$, purchase low-quality chicken, where $w^*(s)$ is given as:

$$w^*(s) = \frac{(\bar{w} + n\gamma)}{n+1} \quad (12)$$

With an increase in the standard s , there are two key outcomes. First, the market share of high-quality chicken remains constant. This is due to an increase in consumer willingness to pay for high-quality chicken being exactly offset by a decrease in the quantity of high-quality chicken

purchased, which follows from low-quality chicken being priced competitively.⁸ Second, there is an increase in the total supply of credence attributes S . Using (9), S is defined as:

$$S = nq^*(s)s = \frac{nN(\bar{w} - \gamma)s}{(n+1)\bar{w}} \quad (13)$$

Club Standards

In the absence of an activist, the n processors of high-quality chicken can join together in a club in order to set a standard s . This draws on the literature that examines voluntary environmental agreements through the lens of club theory (Potoski and Prakash, 2009), the only difference being that both club members and consumers benefit from provision of the credence good. Due to members of the club being identical, they agree on a standard to maximize $\Pi_i(s)$. Given operating profit $\pi_i^*(s)$ from (5), the optimal club standard s^* is:

$$s^* = \frac{N(\bar{w} - \gamma)^2}{(n+1)\bar{w}} \quad (14)$$

and the total supply of credence attributes is:

$$S^* = \frac{nN^2(\bar{w} - \gamma)^3}{(n+1)^3\bar{w}^3k} \quad (15)$$

Finally, the profit for processors of high-quality chicken is:

$$\Pi_i(s^*) = \frac{N^2(\bar{w} - \gamma)^4}{(n+1)^4\bar{w}^2k} - \frac{1}{2}ks^{*2} \quad (16)$$

Several key results drop out of (14) and (15): first, the optimal club standard s^* and the total supply of credence attributes S^* are increasing in the willingness of consumers to pay for high-quality chicken, \bar{w} , and the size of the market N ; second, s^* and S^* are decreasing in both the

⁸ Following Baron (2009b), if it is assumed that processors selling low-quality chicken can price above marginal cost, $p_0 > c_0$, an increase in the standard will reduce (increase) the market share of processors selling high-quality (low-quality) chicken.

marginal and fixed costs of supplying high-quality chicken, γ and k , and decreasing in the size of the club, n . The latter result reflects the fact that, under Nash-Cournot competition, $\partial \pi_i^*(s) / \partial s$ is falling as the number of processors n in the club increases. In the limit as n increases, both $s^* \rightarrow 0$ and $S^* \rightarrow 0$, and the price of high-quality chicken would be forced to the competitive price p_0 . In other words, oligopolistic rents are necessary for firms to rationally supply the credence good.⁹

Activist(s) and Standards

Pressure on firms to supply a credence good can come through either “public” or “private” politics (Baron, 2001; 2003; 2009a; 2011; Baron and Diermeier, 2007). The former takes place through the standard governmental process, resulting in regulation via mandatory food safety standards, and enforcement of those standards through the courts. The latter is the application of direct pressure by citizens outside of the governmental system with the objective of getting firms to supply certified credence goods. In the case analyzed in this paper, pressure through private politics substitutes for public politics if the UK-US FTA is based on “lower” US rather than “higher” EU food safety standards, the agents for pressure being an activist(s)/NGO(s) that draws support from UK citizens.

The activist is assumed to make a demand of poultry processors in the club to set a standard s_A higher than s , the standard set by the club. If firms in the club do not accede to the demands of the activist, a campaign is conducted against the club, the campaign being a credible threat in the sense that it can damage the reputation of poultry processors through a boycott (Innes, 2006).¹⁰ If firms in the club choose to counter the campaign, there is a contest, the result of which determines the equilibrium standard. The outcome of the contest depends on the campaign expenditures of

⁹ See Besley and Ghatak (2007) for discussion of necessity of rents in provision of credence goods.

¹⁰ A more developed model of the poultry production chain would allow for the possibility of a boycott to occur through food retailers, who then signal through contracts their processing requirements.

the activist a , and the expenditure of the club in resisting the campaign, r , where it is assumed that the probability of a successful campaign by the activist is increasing in a and decreasing in r , the probability of activist success being:

$$\rho = \frac{\beta a}{\beta a + r} \quad (17)$$

where $\beta > 0$ is a parameter reflecting the brand equity of members of the club that could be reduced by the activist's campaign.¹¹

The expected utility of the activist, EU_A is given as:

$$EU_A = \rho s_A q_s^*(s_A) + (1 - \rho) s q_s^*(s) - a \quad (18)$$

where $q_s^*(\cdot)$ is the quantity of the credence good if the campaign either succeeds or fails.

The expected profit of club firms, $E\Pi_s$ is:

$$E\Pi_s = \rho n\Pi_i(s_A) + (1 - \rho)n\Pi_i(s) - r \quad (19)$$

where the stake of club firms in the contest is, $\Delta\Pi_s(s, s_A) = n\Pi_i(s) - n\Pi_i(s_A)$. This stake is positive if the standard sought by the activist is greater than what the club would set in the absence of an activist, $s_A > s^*$, i.e., the net effect of the higher standard s_A is to decrease club profits, due to the fixed costs of supplying the higher standard increasing by more than the increase in operating profits. Consequently, the higher the standard demanded by the activist, the greater the incentive of the club to fight the activist campaign, the stake being:

$$\Delta\Pi_s(s, s_A) = n(s_A - s) \left[-\frac{N(\bar{w} - \gamma)^2}{(n+1)^2 \bar{w}} + \frac{1}{2} k(s + s_A) \right] \quad (20)$$

¹¹ While potential damage to club firms' brand equity occurs through the activist's credible threat of a boycott, it might also occur through the stock market price of club firms which is not modeled here. See, for example, Baron (2009a) for a discussion of how corporate social responsibility can be reflected in the capital market.

For the activist, their stake in the contest is given as:

$$\Delta S = s_A q_s^*(s_A) - s q_s^*(s) = \frac{nN}{(n+1)\bar{w}} (\bar{w} - \gamma)(s_A - s) \quad (21)$$

where ΔS is increasing in the willingness of consumers to pay for the credence good, \bar{w} , and the size of the market, N , but decreasing in the credence standard s that would otherwise be set by the club.

The probability that the activist campaign succeeds is given as:

$$\rho^*(s) = \frac{\beta \Delta S}{\beta \Delta S + \Delta \Pi_s(s, s_A)} = \frac{\beta N (\bar{w} - \gamma)}{\beta N (\bar{w} - \gamma) + \frac{1}{2} k (n+1) \bar{w} (s + s_A) - \frac{N (\bar{w} - \gamma)^2}{n+1}} \quad (22)$$

Several key results follow from (22). First, the probability of the activist being successful is decreasing in s and s_A . This follows from firm profits increasing in the average standard $1/2(s + s_A)$, so that either a higher standard set by the club or demanded by the activist increases the stake of the club relative to the activist. Second, the probability of a successful campaign is also decreasing in the size of the club, n . Third, the probability of success is increasing in the size of the market, N , the willingness of consumers to pay for the credence good, \bar{w} , and the brand equity of club firms, β . Fourth, the probability of success decreasing in the marginal and fixed costs of setting higher standards.

In equilibrium, the activist gets expected utility of:

$$\begin{aligned} EU_A &= s q_s^*(s) + \rho^*(s) [s_A q_s(s_A) - s q_s^*(s)] - a \\ &= s q_s^*(s) + \rho^*(s)^2 \frac{N}{2\bar{w}} (\bar{w} - \gamma)(s - s_A) \end{aligned} \quad (23)$$

the activist gaining from engaging in a campaign.

The club earns expected profits of:

$$E\Pi_s = \Pi_s(s_A) + (1 - \rho_c^*(s))^2 \Delta\Pi_s(s, s_A) \quad (24)$$

the club gaining from contesting the activist campaign if its stake is positive.

Once under pressure from an activist, the club takes into account two factors when selecting the standard for processing high-quality chicken: setting a higher standard reduces the likelihood of the campaign being successful (a contest effect), offset by the fact that profits will be lower if the campaign fails (a product market effect). An optimal standard s^o is one that maximizes $E\Pi_s$:

$$\left. \frac{dE\Pi_s}{ds} \right|_{s=s^o} = -2[1 - p^*(s^o)] \frac{d\rho(s^o)}{ds} \Delta\Pi_s(s, s_A) + [1 - p^*(s^o)]^2 \frac{d\Pi_s(s^o)}{ds} = 0 \quad (25)$$

where the first and second terms in (25) are the contest and product market effects respectively, the latter being negative for $s > s^*$.

Given the standard s^* that would have been set in the absence of pressure from an activist, pressure results in the club setting a standard s^o such that, $s_A > s^o > s^*$, i.e., the contest effect exceeds the product market effect. The proof of this result is as follows: the derivative in (25) can be rewritten as:

$$\frac{dE\Pi_s}{ds} = -2 \frac{d\rho^*(s)}{ds} (s_A - s) \left(\frac{1}{2} (s_A + s) - s^* \right) + [1 - p^*(s)] (s^* - s) \quad (26)$$

If (26) is evaluated at $s = s^*$, $dE\Pi_s / ds > 0$, i.e., the club has an incentive to raise the standard above the level it would voluntarily set in the absence of pressure from the activist. In contrast, if (26) is evaluated at $s = s_A$, $dE\Pi_s / ds < 0$, i.e., the club has an incentive to set a standard below that being demanded by the activist. For $s_A > s^o > s^*$, need to show expected profit of the club is strictly concave for $s \in [s^*, s_A]$. Taking the second derivative of (26):

$$\frac{d^2 E\Pi_s}{ds^2} = -2 \frac{d^2 \rho^*(s)}{ds^2} (s_A - s) \left(\frac{1}{2} (s_A + s) - s^* \right) - 3 \frac{d\rho^*(s)}{ds} (s^* - s) - [1 - p^*(s)] \quad (27)$$

where $d^2 \rho^*(s) / ds^2 > 0$. The first and second terms are non-positive for $s \in [s^*, s_A]$, and the third term is negative, therefore $d^2 E\Pi_s / ds^2 < 0$.

In terms of comparative statics, the optimal standard s^o is increasing in the standard demanded by an activist, s_A , the greater the brand equity of firms in the credence club, β , the willingness of consumers to pay for the credence good, \bar{w} , and the size of the market, N , and decreasing in the fixed and marginal costs of producing the credence good, k and γ , and the extent of competition in poultry processing, n .¹²

4. Welfare Implications

The key result of the previous section is that either poultry processors voluntarily set verifiable standards for the production of high-quality chicken, or they set a higher standard in the presence of private political pressure from an activist. This has several key implications for the debate over the welfare outcome of the UK of lowering its food safety standards post-Brexit if it were to sign an FTA with the US:

(i) First, the higher is UK consumer willingness to pay for high-quality chicken, \bar{w} , the greater the incentive for poultry processors to set high standards in the absence of EU mandatory standards. Results from a poll conducted in 2018 for the think Tank IPPR (IPPR, 2018) found that 82 percent of those polled would prefer to maintain existing (EU) food safety standards in any trade deal negotiated with the US. While this is clearly not a measure of willingness to pay, it suggests UK consumers are not actively seeking lower-priced imports of chicken from the US if

¹² See Baron (2011) for proof of these results.

current food safety standards were lowered. In addition, a study by Gschwandtner and Burton (2017) shows that UK consumers do have a willingness to pay for chicken produced under conditions that take account of both animal welfare and the environment.

(ii) Second, the existence of an organized activist placing external pressure on the UK poultry processing sector is critical, especially if the standard set voluntarily by the club is less than that already in place under mandatory EU food safety standards. As noted earlier, there are NGOs such as Sustain in the UK, that are very focused on post-Brexit food safety standards, who will likely put pressure on both the UK government and the poultry industry to maintain current standards (Sustain, January 5, 2018; January 29, 2018; March 3, 2019). In addition, if non PRT-use is a key part of maintaining animal welfare standards in poultry production, NGOs such as People for the Ethical treatment of Animals (PETA) are also likely to continue to be involved in activist behavior at both the chicken production and processing stages of the chain, resulting in upward pressure on s_A and hence s^o .¹³

(iii) Third, if a UK-US FTA is based on US food safety standards, UK consumers who were previously unwilling to pay for high-quality chicken, $w \leq w^*(s)$ will be able to consume imported lower-quality chicken at lower prices.¹⁴ Assuming that those consumers who are willing to pay for high quality chicken, $w \geq w^*(s)$ are able to purchase the certified credence good, there is a potential for aggregate consumer welfare to increase. For example, suppose in the distribution of consumers that there is a mass point $w = 0$ representing those consumers who do not value high-

¹³ See for example, PETA, <https://www.peta.org/issues/animals-used-for-food/factory-farming/chickens/chicken-industry/>

¹⁴ The US is the second largest exporter of poultry meat, and the average price of US chicken is 79 percent that of the same product in the UK (Congressional Research Service, 2017; Adam Smith Institute, 2017).

quality chicken, and letting η denote the mass, demand for high-quality, q_s , and low-quality chicken, q_0 , respectively are given as:

$$q_s = (1-\eta)N\left(1 - \frac{w(s)}{\bar{w}}\right) \text{ and } q_0 = N\left(\eta + (1-\eta)\frac{w(s)}{\bar{w}}\right) \quad (28)$$

therefore, aggregate consumer surplus post-Brexit could exceed that for pre-Brexit:

$$[q_s(w_0 + w_s - p_s) + q_0(w_0 - p_0)]^{post-Brexit} > [q_s(w_0 + w_s - p_s)]^{pre-Brexit} | q_0 = 0 \quad (29)$$

If consumer willingness to pay is also correlated with ability to pay, this result implies that low income consumers will now be able to purchase low-quality chicken. This does of course assume that consuming low-quality chicken imported from the US is safe.

(iv) Fourth, the impact of the UK's trading arrangements with the EU post-Brexit will depend on whether it remains in the EU customs union or chooses to trade on a WTO tariff schedule. Specifically, there will be offsetting effects in either case. With a customs union, tariff-free trade in processed chicken will impact the incentive for UK processors to set a high standard via the parameter N , assuming that certified UK exports of high-quality chicken meet existing EU food safety standards; however, this will be offset by the number of processors, n competing in the UK market for high-quality chicken which will lower the standards set by UK firms. The opposite holds under a WTO tariff schedule where both N and n are smaller, i.e., lower access to the EU market will lessen the incentive for UK processors to set a high standard, while less competition from EU suppliers of processed poultry will increase the potential rents for UK processors, thereby resulting in a higher standard.¹⁵

¹⁵ As entry is not modeled, it is not possible to be precise about the possible effect of tariffs on the number of poultry processors competing in the UK.

5. Summary and Conclusions

The focus of this paper is the potential impact on the UK's food safety standards of its post-Brexit trading relationship with the EU, and also any free trade agreements it negotiates outside of the EU. This issue has been the subject of much public debate as concerns about a race to the bottom in food safety standards have intensified with political and media discussion of the potential for the UK having to accept US food safety standards in a future UK-US FTA, and with it imports of products such as chlorinated chicken.

In this context, the analysis presented in the paper draws on a literature in public economics that suggests non-chlorinated chicken, a credence good, could be supplied by an organization of UK poultry processors, either voluntarily or due to pressure from an activist(s) (Baron, 2009b; 2011). The results of the analysis suggest that if UK consumers have a high willingness to pay for non-chlorinated chicken, a credence good will be supplied at the same time as chlorinated chicken is imported from the US. The level of any voluntary food safety standard for poultry processing would be determined by the costs of supplying the credence good, the size of the market for non-chlorinated chicken, the extent of competition in the UK poultry processing sector, and the nature of the UK's post-Brexit trading arrangements.

While the model presented in this paper is a pretty robust way of analyzing the key issue(s), it could be usefully extended in a number of directions that might better capture specific institutional details. First, the assumption that the activist(s) only put pressure on processors of high-quality chicken ignores the possibility that they will also target imports of low-quality chicken from the US. In this case, low-quality processors could end up producing at a higher standard than the club, resulting in consumers with a low willingness to pay for high-quality

chicken being squeezed out of the market.¹⁶ Second, given the focus of existing EU food safety standards on the whole food chain, it would be useful to set the UK poultry processing in the context of upstream poultry producers and downstream food retailers. Specifically, if existing EU poultry production standards are aimed at the joint issues of animal welfare and food safety, modeling activist behavior in this context is relevant. In addition, given that UK food retailers who market chicken to consumers could be subject to a consumer boycott, they have an incentive either to be part of any coalition placing pressure on upstream poultry processors. Alternatively, a club of retailers could choose to set their own standards for processed chicken which are then enforced under contract with upstream processors, and at the same time refuse to source imported processed chicken from the US. Third, the analysis assumes that there is only private political pressure, but this could be extended to allow for public political pressure on UK food safety regulators to set high minimum food safety standards in a setting where an activist demands higher a higher standard.¹⁷

In conclusion, the results presented in the paper suggest that the popular view of the impact of Brexit on the UK's food safety standards should be tempered by the possibility that the UK market for processed chicken will not necessarily collapse if "the 'chlorinated chicken' crosses the pond". Obviously this result is sensitive to several key parameters noted in the analysis, but it does suggest that given the apparent strength of UK public opinion, if reflected in consumer willingness to pay for non-chlorinated chicken, along with the clear potential for activist pressure, Brexit does not have to have a negative impact on its food safety standards, even if those standards are nominally lowered in any UK-US FTA. In addition, some (low income) consumers may benefit due to the availability of imported low-price chlorinated chicken.

¹⁶ Baron (2009b) models this possibility.

¹⁷ See Bottega and DeFreitas (2009) for an example of this type of analysis.

References

- Adam Smith Institute. April 2017. Chlorinated chicken: Why you shouldn't give a cluck. <https://static1.squarespace.com/static/56eddde762cd9413e151ac92/t/597532c759cc6804bf00229f/1500852936276/Chlorinated+Chicken.pdf>
- Agriculture and Horticulture Development Board (AHDB). 2018. *Poultry Pocketbook*, Kenilworth: AHDB.
- Akerlof GA. 1970. The market for "lemons": quality uncertainty and the market mechanism. *Quarterly Journal of Economics* 84(3): 488-500.
- Allen F. 1984. Reputation and product quality. *Rand Journal of Economics* 15(3): 311-327.
- Argenti PA. 2004. Collaborating with activists: how Starbucks works with NGOs. *California Management Review* 47(1): 91-116.
- Baird IG., Quastel N. (2011). "Dolphin-safe tuna from California to Thailand" Localisms in environmental certification of global commodity networks. *Annals of the Association of American Geographers* 101(2): 337-355.
- Bagwell K, Riordan M.H. 1991. High and declining prices signal product quality. *American Economic Review* 81(1): 224-239.
- Baron DP. 2001. Private politics, corporate social responsibility, and integrated strategy. *Journal of Economics and Management Strategy* 10(1): 7-45.
- Baron DP. 2003. Private politics. *Journal of Economics and Management Strategy* 12(1): 31-66.
- Baron DP. 2009a. A positive theory of moral management, social pressure, and corporate social performance. *Journal of Economics and Management Strategy* 18(1): 7-43.
- Baron DP. 2009b. Clubs, credence standards, and social pressure. In Potoski M., Prakash A. (eds), *Voluntary Programs: A Club Theory Perspective*, Cambridge, MA: MIT Press.
- Baron DP. 2011. Credence attributes, voluntary organizations, and social pressure. *Journal of Public Economics* 95(11): 1331-1338.
- Baron DP., Diermeier D. 2007. Strategic activism and nonmarket strategy. *Journal of Economics and Management Strategy* 16(3): 599-634.
- Besley T., Ghatak M. 2007. Retailing public goods: The economics of corporate social responsibility. *Journal of Public Economics* 91(9): 1645-1663.
- Bonroy O, Constantos C. 2015. On the economics of labels: how their introduction affects the functioning of markets and the welfare of all participants. *American Journal of Agricultural Economics* 97(1): 239-259.
- Bonroy O, Lemarié S. 2012. Downstream labeling and upstream price competition. *European Economic Review* 56(3): 347-360.
- Bottega L., De Freitas J. 2009. Public, private and nonprofit regulation for environmental quality. *Journal of Economics and Management Strategy* 18(1): 105-123.
- Caswell J, Mojduszka E. 1996. Using informational labeling to influence the market for quality in food products. *American Journal of Agricultural Economics* 78(5): 1248-1253.
- Cezar RF. 2018. The politics of 'dolphin-safe' tuna in the United States: Policy change and reversal, lock-in and adjustment to international constraints (1984-2017). *World Trade Review* 17(4): 635-663.
- Colantone I., Stanig P. 2018. Global competition and Brexit. *American Political Science Review* 112(2): 201-218.
- Congressional Research Service, January 5, 2017. *US-EU Poultry Dispute on the Use of Pathogen Reduction Treatments (PRTs)*. Washington DC: Congressional Research Service.

- Darby MR, Karni E. 1973. Free competition and the optimal amount of fraud. *Journal of Law and Economics* 16(1): 67-88.
- Dawson S. August 2, 2017. Chlorine-washed chicken Q&A: food safety expert explains why US poultry is banned in the EU. The Conversation.
<https://theconversation.com/chlorine-washed-chicken-qanda-food-safety-expert-explains-why-us-poultry-is-banned-in-the-eu-81921>
- Dulleck U, Kerschbamer R. 2006. On doctors, mechanics, and computer specialists: the economics of credence goods. *Journal of Economic Literature* 44(March): 5-42.
- The European Commission. 2008. *Environmental impact and effect on antimicrobial resistance of four substances used for removal of microbial surface contamination of poultry carcasses*. Brussels: Scientific Committee on Health and Environmental Risks, European Commission.
- European Food Safety Agency. 2005. Treatment of poultry carcasses with chlorine dioxide, acidified sodium chlorite, trisodium phosphate and peroxyacids. *The EFSA Journal* 297: 1-27.
- European Food Safety Agency. 2008. Assessment of the possible effect of the four antimicrobial treatment substances on the emergence of antimicrobial resistance. *The EFSA Journal* 659: 1-26.
- Fedderson TF, Gilligan TW. 2001. Saints and markets: activists and the supply of credence goods. *Journal of Economics and Management Strategy* 10(1): 149-171.
- Gschwandtner A., Burton M. January 2017. The willingness to pay for organic attributes in the UK. KDPE 1702, Canterbury: University of Kent.
- The Grocer*. December 3, 2018. Half of shoppers desert meat if UK allows chlorinated chicken imports.
<https://www.thegrocer.co.uk/brexit/half-of-shoppers-to-desert-meat-if-uk-allows-chlorinated-chicken-imports-/574438.article>
- The Guardian*. November 6, 2017. Trump advisor Ross says UK-EU trade deal will mean scrapping EU rules. <https://www.theguardian.com/business/2017/nov/06/trump-ross-says-uk-us-trade-deal-eu-brexit-chlorinated-chicken>
- The Guardian*. May 26, 2018. Chicken safety fear as chlorine washing fails bacteria tests.
<https://www.theguardian.com/world/2018/may/26/chicken-health-fear-chlorine-washing-fails-bacteria-tests-brexit-salmonella-listeria>
- The Guardian*. March 1, 2019. Concern over food safety as US seeks access to UK markets.
<https://www.theguardian.com/politics/2019/mar/01/us-seeks-greater-access-to-uk-food-markets-after-brexit-trade-deal>
- The Guardian*. March 6, 2019. The UK can't accept backward US food standards – or chlorinated chicken.
<https://www.theguardian.com/commentisfree/2019/mar/06/us-chlorinated-chicken-trade-deal-agriculture>
- Heyes AG, Maxwell JW. 2004. Private vs. public regulation: political economy of the international environment. *Journal of Environmental Economics and Management* 48(2): 978-966.
- Highmore CJ., Warner JC., Rothwell, JD., Wilks, SA., Keevil, CW. 2018. Viable-but-nonculturable *Listeria monocytogenes* and *Salmonella enterica* serovar Thompson induced by chlorine remain infectious. *mBio* 9(2): 1-12.
- HM Government, 2018. *EU Exit: Long-Term Economic Analysis*, Cmnd 9742, London: UK Government Publications.

- Hobbes T. (1968). *Leviathan*, London: Penguin.
- The Independent*. May 15, 2019. Brexit: Liam Fox claims UK could accept chlorinated chicken in US trade deal without lowering food standards.
<https://www.independent.co.uk/news/uk/politics/brexit-uk-us-trade-deal-food-standards-chicken-liam-fox-trump-a8914621.html>
- Innes R. 2006. A theory of consumer boycotts under symmetric information and imperfect competition. *Economic Journal* 100(511): 355-381.
- IPPR. April 4, 2017. Public willing to sacrifice US trade deal to protect food safety.
<https://www.ippr.org/news-and-media/press-releases/public-willing-to-sacrifice-us-trade-deal-to-protect-food-safety>
- Kiesel K, McCluskey JJ, Villas-Boas SB. 2011. Nutritional labeling and consumer choices. *Annual Review of Resource Economics* 3(1): 141-158.
- Klein B, Leffler KB. 1981. The role of market forces in assuring contractual performance. *Journal of Political Economy* 89(4): 615-641.
- Körber A. 1998. Why everybody loves Flipper: the political economy of the US dolphin-safe laws. *European Journal of Political Economy* 14(3): 475-509.
- Marette S, Crespi J, Schiavina A. 1999. The role of common labeling in a context of asymmetric information. *European Review of Agricultural Economics* 26(2): 167-178.
- Mattoo A., Staiger RW. Forthcoming. Trade wars: What do they mean? Why are they happening now? What are the costs? In Crowley MA. (ed.) *Trade Wars*, London: CEPR.
- Maxwell JW, Lyon TP, Hackett SC. 2000. Self-regulation and social welfare: the political economy of corporate environmentalism. *Journal of Law and Economics* 43(2): 583-618.
- McCluskey JJ. 2000. A game theoretic approach to organic foods: an analysis of asymmetric information and policy. *Agricultural and Resource Economics Review* 29(1): 1-9.
- Millstone E., Lang E., Marsden T. 2017. *Will the British public accept chlorine-washed turkey for Christmas, after Brexit?* FRC Food Brexit Policy Briefing, Centre for Food Policy, London: City, University of London.
[file:///C:/Users/sheldon.1/Downloads/FRCBrexitBriefing_ChlorineWashedTurkeyForChristmas%20\(1\).pdf](file:///C:/Users/sheldon.1/Downloads/FRCBrexitBriefing_ChlorineWashedTurkeyForChristmas%20(1).pdf)
- National Public Radio (NPR). September 30, 2014. European activists say they don't want any US 'chlorine chicken'.
- Nelson P. 1970. Information and consumer behavior. *Journal of Political Economy* 78(2): 311-329. <https://www.npr.org/sections/thesalt/2014/09/30/351774240/european-activists-say-they-dont-want-any-u-s-chlorine-chicken>
- Nozick R. (1974). *Anarchy, State, and Utopia*, New York, NY: Basic Books.
- Potoski M., Prakash A. (eds), *Voluntary Programs: A Club Theory Perspective*, Cambridge, MA: MIT Press.
- The Observer*. January 29, 2017. Is chlorinated chicken about to hit our shelves after new US trade deal? <https://www.theguardian.com/environment/2017/jan/29/britain-us-trade-deal-gm-food-eu-rules>
- Riordan M. 1986. Monopolistic competition with experience goods. *Quarterly Journal of Economics* 101(2): 265-279.
- Roe B, Sheldon I. 2007. Credence good labeling: the efficiency and distributional implications of several policy approaches. *American Journal of Agricultural Economics* 89(4):1020-1033.
- Roe BE, Teisl MF, Deans C. 2014. The economics of voluntary versus mandatory labels. *Annual Review of Resource Economics* 6(1): 1-21.

- Segerson K. 1999. Mandatory versus voluntary approaches to food safety. *Agribusiness* 15(1): 53-70.
- Sexton R. 2013. Market power, misconceptions, and modern agricultural markets. *American Journal of Agricultural Economics* 95(2): 209-219.
- Shapiro C. 1983. Premiums for high quality products as returns to reputations. *Quarterly Journal of Economics* 98(4): 659-680.
- Sheldon IM. 2017. Certification mechanisms for credence attributes of foods: Does it matter who provides diagnosis? *Annual Review of Resource Economics* 9: 33-51.
- Siegel DS, Vitaliano D.F. 2007. An empirical analysis of the strategic use of corporate social responsibility. *Journal of Economics and Management Strategy* 16(3): 773-792.
- Sustain. January 5, 2018. UK will not 'shut up' about chlorine-rinsed poultry after US complaints. <https://www.foodnavigator.com/Article/2018/01/05/UK-will-not-shut-up-about-chlorine-rinsed-poultry-after-US-complaints>
- Sustain. January 29, 2018. Race to the top: Sustain's 10 red lines for UK trade deals for food, farming and fishing. https://www.sustainweb.org/blogs/jan18_10_red_lines_for_food_trade_deals/
- Sustain. March 4, 2019. Sustain responds to US ambassador about chlorine chicken claims. https://www.sustainweb.org/news/mar19_us_ambassador_rebuttal/
- The Telegraph*. July 24, 2017. Liam Fox mocks concerns over chlorine-washed chicken and insists it is just 'detail' of trade deal with US. <https://www.telegraph.co.uk/news/2017/07/24/liam-fox-mocks-concerns-chlorinated-chicken-insists-just-detail/>
- The Telegraph*. March 2 2019. US ambassador says Britain should embrace American farming methods such as chlorinated chicken. <https://www.telegraph.co.uk/politics/2019/03/01/britain-should-embrace-us-farming-methods-agree-trade-deal-says/>
- UK Trade Forum. September 20, 2017. What chlorinated chicken tells us about Brexit. <https://uktradeforum.net/2017/09/20/what-chlorinated-chicken-tells-us-about-brexite/>
- US Trade Representative (USTR). February 2019. *United States-United Kingdom Negotiations: Summary of Specific Negotiating Objectives*. Washington DC: Office of the United States Trade Representative.
- The Washington Post*. December 4, 2014. Free trade with US? Europe balks at chlorine chicken, hormone beef. https://www.washingtonpost.com/world/europe/free-trade-with-us-europe-balks-at-chlorine-chicken-hormone-beef/2014/12/04/e9aa131c-6c3f-11e4-bafd-6598192a448d_story.html?utm_term=.6aa0c2551192
- World Trade Organization (WTO). *European Communities – Certain Measures Affecting Poultry Meat and Poultry Meat Products from the United States*. DS389, Geneva: World Trade Organization.
- Wright BG., Environmental NGOs and the dolphin-tuna case. *Journal of Environmental Politics* 9(4): 82-103.
- Zago AM, Pick D. 2004. Labeling policies in food markets: private incentives, public intervention, and welfare effects. *Journal of Agricultural and Resource Economics* 29(1): 150-16.