"Certification Mechanisms for Credence Attributes of Foods: Does it Matter Who Provides Diagnosis?"*

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November 2016

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Abstract

Credence goods markets are subject to failure due to consumers being unable to punish fraudulent experts diagnosing and supplying treatment, and because consumers lack the technical expertise with which to verify the quality of treatment actually offered. The focus of research in agricultural economics has been almost entirely on how labeling and certification of food products containing credence attributes resolves the lemons problem. This ignores the crucial role that firms, NGOs or government regulatory agencies, acting either independently or jointly as experts, play in the process of diagnosis and treatment in credence good markets. This matters if experts fail to act in good faith through their diagnosis and treatment.

Keywords: Credence goods, diagnosis and treatment, labeling and certification

JEL Codes: D82, L5, L15, Q18

Introduction

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, and also contribute to resolving known externalities associated with food production (shade-grown coffee). 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 the economics literature, the term credence good refers to a good where consumers are never able to discover how much of the good they actually need and they are also unable to establish the quality of the good even after consumption (Emons, 2001). Importantly, sellers not only provide the good to consumers, but they also act as "experts" determining the needs of consumers. As pointed out originally by Darby and Karni (1973) and discussed at length in Dulleck and Kerschbamer (2006), there is considerable potential for fraud where experts have an incentive to exploit informational asymmetries at both "diagnosis" and "treatment" stages in markets for credence goods. The canonical example of this is an expert, a doctor (car mechanic), diagnosing a medical (mechanical) problem and providing treatment (repairs). The problem facing the consumer is that they have insufficient information to judge whether the diagnosis is actually correct and also whether they have actually received the appropriate level of treatment. In other words, experts know more about the type of good that a consumer needs (diagnosis), and may

exploit that informational asymmetry by defrauding the consumer in terms of the quality of the good actually provided (treatment).

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). 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), all the time ignoring 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.

It is important to recognize though that the diagnosis stage for credence foods may be the outcome of explicit interaction between firms and other agents, the latter including regulatory agencies and non-governmental organizations (NGOs). This may result in the "correct" diagnosis by firms and these other agents, but with different levels of proposed treatment Baron (2011). For example, interaction between the tuna-industry, the US government, and environmental NGOs concerning protection of dolphins, and eventual use of certification of a credence attribute through application of the "dolphin-friendly" label (Körber, 1998). Here the diagnosis was correct – too many dolphins were being killed in the process of commercial tuna fishing, the appropriate

treatment being a significant reduction in such deaths and certification that tuna fish purchased by consumers in the US was caught through dolphin-friendly methods.

Alternatively, such interaction may result in the "incorrect" diagnosis followed by inappropriate treatment (Sheldon, Roe and Olimov, 2015). For example, it has been suggested that the Dietary Guidelines Advisory Committee in its expert report on the 2015 US dietary guidelines failed to take account of all the relevant scientific evidence relating to saturated fats and the effect of low carbohydrate diets, members of the committee having potential conflicts of interest (Teicholz, 2015). In other words diagnosis provided by experts concerning a healthy diet, signaled to consumers through a mandated label, may either be incorrect or at least slow to be adapted to new scientific findings.

In this context, the purpose of this article is twofold: to review some of the main findings in the agricultural economics literature concerning the economic effects of labeling and certification of food products with credence attributes, and to consider whether who provides the diagnosis and treatment associated with credence attributes matters when the consumer knows what treatment they are actually getting due to labeling and certification. The remainder of the article proceeds as follows: first, an outline of how credence goods have been analyzed in the economics literature is presented; second, a selective review is conducted of some of the key findings in the agricultural economics research concerning credence goods; and, third, some issues relating to diagnosis in the case of credence attributes in food are described and discussed.

1. 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 Kerscbamer (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.

In their review, Dulleck and Kerschbamer (2006) use a simple to highlight the information problems endemic to markets for experts' services, and also to rationalize the majority of key results presented in the literature once conditions (i) to (iii) are successively relaxed. Following their notation, the typical credence good game has the following structure: on the supply side, there are $n \geq 1$ risk-neutral experts, where each expert can serve many consumers, $i = 1,...,n$ experts simultaneously posting prices $\underline{p}_i$ and $\overline{p}_i$ for the simple and complex treatments respectively. Each expert earns a profit consisting of total revenue minus the costs of treatment actually provided, where $\underline{c}$ and $\overline{c}$ are the costs of supplying the simple and complex treatments respectively. On the demand side, there is a continuum of risk-neutral consumers, where *ex ante*, consumers know that they have a problem requiring treatment, where *h* is the probability they need complex treatment. On consulting an expert, each consumer incurs a diagnosis cost *d*, and if they accept treatment, their net payoff is $u - p - d$, where $u \in [v, 0]$ and $p \in [\underline{p}_i, \overline{p}_i]$, v being the consumer's utility if the treatment provided is sufficient.

In its simplest form, a single expert ($n = 1$) seeks the patronage of single consumer, the variables v, h, $\underline{c}$ and $\overline{c}$ being known to both players, the expert offering prices $\underline{p}$ and $\overline{p}$ respectively. The game then proceeds as follows: (a) the consumer observes prices *p* and decides whether to visit the expert; (b) if the consumer visits the expert, nature randomly determines the nature of their problem; (c) the expert then diagnoses the consumer, and in so doing learns the consumer's problem and recommends either the simple or complex treatment; (d) the consumer can then reject or accept the recommended treatment, and if they accept, the expert provides some type of treatment and charges for the recommended one. Extending the game to many consumers and many experts $(n > 1)$, where *h* is the fraction of consumers requiring the complex treatment, consumers observe posted prices *p* and decide whether to seek a diagnosis from an expert or not,

and from which expert. Payoffs now allow for a consumer rejecting the diagnosis of one expert and seeking a second opinion(s), the cost being *rd*, where *r* is the number of experts visited. Where consumers are committed to accepting treatment, the solution to the game is sub-game perfect, but if they decide on seeking a second diagnosis uncertain about whether the initially prescribed treatment is correct, the game has a perfect Bayesian equilibrium.

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, $\bar{p} - \bar{c} \leq \underline{p} - \underline{c}$. 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.

Interestingly, the majority of articles in the literature assume that either the liability condition or verifiability holds in the analysis, while relaxing conditions (i) and (ii). Some of the main effects of doing so are as follows: first, in the case of a single expert, if consumers are heterogeneous in terms of their expected cost of efficient treatment, and there is no liability condition, price discrimination occurs (Dulleck and Kerschbamer, 2007). Essentially, the complex diagnosis and appropriate treatment is offered to consumers with a low expected cost of treatment, while consumers with a high expected cost of treatment are induced to consume a complex treatment that is not actually required. Second, suppose there is a rule that fixes prices for complex treatment, but there is no commitment by consumers to buy the complex treatment and no verifiability. In this case, experts may overcharge consumers some of the time in credence good markets (Pitchik

and Schotter, 1987). This follows from the fact that recommending the simple treatment guarantees a positive profit, while earning a positive profit from recommending the complex treatment when only the simple one is required depends on whether the consumer accepts the diagnosis or not. Alternatively, with flexible prices and several experts, there will be specialization with duplicate search and diagnosis costs (Wolinsky, 1993). This result is driven by the assumption that there are "cheap" and "expensive" experts, the former always recommending appropriate treatment, and the latter always recommending complex treatment. If a consumer first visits a cheap expert and is recommended the simple treatment, they accept, but if they are recommended the complex treatment, they then visit the expensive expert and get the complex treatment, i.e., there is no longer any overcharging, as the cheap expert has no incentive to overcharge consumers, but there is costly double advice. With verifiability, specialization disappears as experts set prices closer to costs, such that consumers have less incentive to seek a second opinion.

However, even when conditions (i) and (ii) hold, 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). Specifically, if consumer utility v is sufficiently high, and $n > 1$, each expert charges a constant price $\tilde{p} = \underline{c}$, and always provides the simple treatment, i.e., a lemons market, and if v is too low, the credence goods market does not exist. Of course if complex treatment has the same cost as simple treatment, $\underline{c} = \bar{c}$, experts have no incentive to act fraudulently. 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, reference being made Caswell and Mojduszka (1996) to the US Nutrition Labeling and Education Act which went into force in 1994.

2. Economics of Certification and Labeling

Virtually all agricultural economics analysis focuses on resolution of the lemons problem via labeling and third-party certification, ignoring the role of experts in provision of credence goods. No detailed discussion is offered in this literature as to who provides diagnosis and treatment in the case of food products, essentially assuming that as long as labeling resolves the asymmetric information problem consumers receive the appropriate form of treatment. This ignores the possibility that experts may differ in their ability to perform diagnoses, and also that ability of and effort by experts is unobservable by consumers (Pesendorfer and Wolinsky, 2003; Dulleck and Kerschbamer, 2009). In addition, it is typically assumed that in seeking treatment, consumers

know what they want, and the only problem they face is imperfect information as regards the type of treatment they will receive when purchasing a food product (Bonroy and Constantos, 2015).

Notwithstanding this, the literature has developed to the point where substantive survey articles have reviewed the main findings concerning credence good labeling and certification (Roe, Teisl and Deans, 2014; Bonroy and Constantos, 2015), and the impact of labeling on consumers, especially with respect to nutrition labeling (Kiesel, McCluskey, and Villas-Boas, 2011). Essentially, the authors of the first two surveys ask the same question: what are the potential economic benefits and costs of credence good labeling in the food and agricultural sector? Given the greater emphasis of the current survey on the diagnosis stage of the credence good problem, no attempt is made here to replicate the detail of these surveys, instead the focus is on some of the main takeaway points from this literature, as they relate to treatment, with an emphasis on what is perhaps relevant to a discussion of diagnosis and the role of experts.

Selectively following Bonroy and Constantos (2015), the remainder of this section highlights three issues as they relate to the costs and benefits of labeling of credence attributes in food: first, how might labeling interact with market structure and its associated effects on producers and consumers; second; how does the choice of labeling mechanism affect the treatment level of credence attributes; and third what is the role of NGOs in setting credence good labels? Importantly, the latter two questions provide a link to the subsequent section focusing on diagnosis.

Market Structure

To highlight the potential impact of labeling on market structure, the credence goods model developed in a series of articles by Roe and Sheldon (2007), Sheldon and Roe (2009a; 2009b) is briefly outlined, and some of their key results discussed. Drawing on a model of vertical product differentiation originally due to Shaked and Sutton (1982; 1983), consumers have unit demand for

a quality differentiated good, consumers deriving the same surplus from a good of a specific quality, but differing in their ability to pay. Firms produce a single differentiated product with a technology characterized by zero marginal production costs, and a fixed quality-dependent cost, where all firms incur a sunk entry cost irrespective of quality. Firms maximize their profits in a three-stage game: first, firms choose to enter, incurring a sunk cost; second, firms that have entered simultaneously choose quality, incurring additional fixed costs, and then label their quality levels and pay appropriate certification costs; third, they simultaneously set prices following Bertrand-Nash strategies.

Assuming perfect information about quality, and a uniform distribution of income with a restriction on the width of that distribution, equilibrium market structure is a natural duopoly consisting of one firm supplying a low-quality good and a second firm supplying a high-quality good, i.e., there is no credence good problem. With asymmetric information about quality, the equilibrium market structure collapses to one firm selling the low-quality good. This follows from the fact that if two (or more) firms were to enter, they can only offer the low-quality good at a zero price because of Bertrand-Nash competition, thereby making a loss due to sunk entry costs. Consequently, the perfect equilibrium of the game is one firm enters, selling the low-quality good at the monopoly price. If labeling and certification of the high-quality good is the only policy instrument available it has the potential to resolve the market failure due to imperfect information, as well as mitigate the monopoly distortion. Labeling of the high-quality good allows a second firm to enter the market, consumers getting a greater choice of goods, and Bertrand-Nash duopoly drives down prices, thereby raising consumer welfare.

As pointed out by Bonroy and Constantos (2015), this result is sensitive to the assumption that sunk costs are incurred upon entry, ensuring only one firm enters without labeling. In the

absence of the sunk entry cost, two firms can survive in the market with or without labeling, the key difference being that introducing a label turns the market from a homogeneous product duopoly, with both firms pricing at zero marginal cost, to a differentiated product duopoly where the firm selling the high-quality good raises price, thereby lessening competition on the firm selling the low-quality good. In this case, both firms benefit from labeling, while consumers at the lower end of the income distribution consume the lower-quality good at a higher price, foregoing the 50-50 chance they had of obtaining the high-quality good at a low price under asymmetric information. In this case, the single policy instrument of labeling resolves the credence good market failure, but introduces a duopoly distortion.

This type of result is rather common in the extant agricultural economics literature on credence goods, which typically assumes imperfect horizontal and vertical market structures. For example, Zago and Pick (2004), drawing on the approach to vertical product differentiation of Mussa and Rosen (1978), establish that labeling and certification may not be welfare-enhancing if the market for the high-quality good becomes less competitive. Following Gabszewicz and Grilo (1992), Bonroy and Constantos (2008), assume that the basis for product differentiation is one where consumers have subjective beliefs about which firm supplies low as opposed to high-quality, such that when labeling and certification is introduced, depending on costs, only one firm survives in equilibrium, i.e., there is reverse differentiation which may actually be resisted by both firms.

Finally, Bonroy and Lemarié (2012) consider a vertical market structure consisting of two upstream firms selling an intermediate input to a continuum of firms downstream who process the input into a final food product. Key to the analysis is that downstream firms are ranked by cost efficiency, and therefore their preference for more productive intermediate inputs is also ranked, but such inputs may not be ranked in the same way by consumers, e.g., genetically-modified (GM)

ingredients. Labeling results in consumers being able to choose food products based on the inputs used, such that vertical product differentiation is created in the downstream market, i.e., GM vs. non-GM inputs, which reduces price competition upstream. At the same time, downstream firms may switch their ranking of intermediate inputs. The net effect is that for the high-quality non-GM supply chain, the differentiation and ranking effects push up both intermediate input and final product prices, while these effects work in opposite directions for the intermediate input in the low-quality GM supply chain, i.e., differentiation pushes up its price, while the ranking effect lowers it. This outcome also suggests an interesting result: upstream firms produce an intermediate GM input that has been considered safe by one set of experts, but downstream firms also acting as experts, offer a food product that contains non-GM intermediate inputs.

This discussion highlights two important features of the literature examining market structure and labeling. First, as is typically the case in industrial organization, the range of results from introducing labeling and certification is very sensitive to the underlying assumptions of the modeler. Second, when there are multiple market failures (imperfect competition and asymmetric information), but there are constraints on the number of available policy instruments (labeling only), the welfare outcomes have to be set in the context of the theory of second-best, i.e., solving the asymmetric information problem through labeling and certification may or may not mitigate the distortion due to imperfect competition.

Labeling and Treatment Level

The result derived by Roe and Sheldon (2007) that labeling and certification of a credence good will generate the same equilibrium as under perfect information turns out to be quite sensitive to the institutional details of labeling, a point also emphasized in the reviews by Roe, Teisl and Deans, (2014), and Bonroy and Constantos (2015). For example, in comparing public to private labeling,

the latter review lays out carefully the circumstances under which an industry will under or over-provide quality (treatment) as compared to the socially optimal public level. For example, drawing on Spence (1975), it is shown that if the marginal willingness to pay for improved quality is diminishing, the "demand" effect may result in a monopoly firm setting a standard lower than the social optimum. By contrast, in a duopoly setting, where labeling allows for product differentiation and a lessening of price competition, the firm selling the high-quality good has a "strategic" incentive to seek a higher standard than is socially optimal, given that a social planner would have an incentive to set a lower standard in order to increase price competition if they are unable to regulate firms' prices. Drawing on Motta (1993), it is shown that the demand effect can outweigh the strategic effect, the private standard being less than socially optimal.

In the same vein, Sheldon and Roe (2009b) evaluate public versus private standards in an international setting where two developed economies agree to harmonize their mandatory environmental credence good labeling regulations. If the authorities have exclusive authority to certify and label a discrete level of environmental quality, they risk pushing out the high-quality good if the harmonized standard is too high or too low to yield positive profits for the high-quality producing firm, thereby lowering aggregate environmental benefits. If, however, private certification is also permitted, the welfare gains from economic integration are maximized if regulators permit private certification of a standard different to the harmonized standard - private certification lowering the risk that a higher-quality good is pushed out of the market if public environmental standard(s) are set too low or too high. It should be noted that, with mutual recognition of standards, one country's standard may already be closer to what is privately optimal for a firm to supply the higher-quality good.

Sheldon and Roe (2009b) also extend their analysis to the case where a developed and developing country consider economic integration, such that their joint income distribution is wider than for each individual country under autarky, and with perfect information, three goods being viable in equilibrium, i.e., low, medium and high-quality. If the authorities have exclusive authority to certify and label a discrete level of environmental quality, they risk pushing out either one or both of the medium and high-quality goods, which may also lower aggregate environmental benefits. Again, private certification has the potential to prevent this outcome.

The latter results also have implications for the so-called "race to the bottom" in environmental standards. In the absence of any environmental credence good regulations, only the low-quality good is produced in equilibrium, and *de facto*, standards never leave the bottom. In contrast, once there is mandatory labeling, as long as private certification of discrete labeling is permitted, there will be no race to the bottom as firms have an incentive to produce higher than minimum environmental quality goods in equilibrium, i.e., even if the regulatory authorities "harmonize-down" environmental standards in a race to the bottom, private certification ensures that increased aggregate environmental benefits are still realized.

These results hints at the possibility that the level of treatment offered in credence goods markets is sensitive to who is acting as the expert. In particular, depending on their incentives, firms acting as experts may choose to privately label and certify credence attributes at a lower or higher level than a regulator acting as expert would choose to. The latter outcome also suggests that if private certification is permitted, firms might also act to raise quality either to establish a reputation for corporate social responsibility, or because they come under external pressure from NGOs.

NGOs and Credence Goods

NGOs have become increasingly active with respect to provision of credence attributes in food products (Baron, 2009; 2011). Typically NGOs are confined to organizations advocating stricter standards with respect to negative externalities in either food production or consumption, but there are also NGOs promoting other credence attributes in food such as ethical treatment of animals. Fedderson 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, although as pointed out by Fedderson and Gilligan (2001), information-supplying activists do not necessarily guarantee a socially-optimal outcome.

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 lowe-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.

If private labels set by firms are lower than minimum quality standards set by government, which in turn are lower than voluntary standards set by NGOs, there is the potential that the actual standards implemented will be the outcome of a political-economic game (Bonroy and Constantos, 2015). In the Heyes and Maxwell (2004) setting, firms may resist both minimum and voluntary quality standards if it reduces their profits, such that government reduces the minimum standard in order to increase the chance of it being implemented. By contrast, if the voluntary standard already exists, it may reduce resistance by firms to reduction of the minimum standard.

Alternatively, if the industry initially sets a standard and the NGO then pushes to increase the standard, Baron (2011) shows that the industry standard will be higher than in the absence of pressure from the NGO. In this model, firms can produce either a low-quality good, or a high-quality good with credence attributes, the standard being set by an industry credence organization and credibly certified by a third-party. The level of the standard is a function of the number of firms in the organization, and once collectively set, these firms compete in the high-quality segment of the market, while firms outside the organization sell the low-quality good. Preferences for the credence attribute are drawn from a uniform distribution of consumers. Baron (2011) models the problem as a four-stage game: first, the NGO demands the industry set a standard, after which the credence organization sets a standard; second, the NGO directs social pressure on the organization; third, the NGO and its target organization contest a campaign; fourth, given the outcome of the campaign, there is Cournot-Nash competition in the product market.

There is a tradeoff for the credence organization: a higher standard decreases the chance the NGO campaign is successful, but a higher standard also reduces profits if the NGO campaign fails. This results in the credence organization setting a standard that lies between what would be optimal in the absence of an NGO campaign, and what the NGO seeks in a standard. This optimal standard is increasing in the strength of the demand of the NGO, the strength of public sentiment for the NGO's campaign, and the size of the market and strength of preferences for the credence good, but is decreasing in the fixed costs of supplying high-quality and the marginal costs of meeting the credence standard.

A key point about the political economy view of standards is that it not only highlights how relative political power between firms and NGOs may determine which type of standard is set to resolve the credence good problem, it also assumes that if the government participates as a social planner, it always seeks to maximize social welfare, ignoring the possibility of regulatory capture. This also reinforces the argument made earlier that more attention should be given to who are the experts and how they influence the level of treatment embodied in credence goods.

3. Diagnosis and Treatment

Several features of the game outlined in section 1 can be adapted to the case of food: consumers face firms selling food product(s) at various prices, where the treatment offered is a labeled and certified credence characteristic(s); consumers may be uncertain about the claimed benefits of the treatment, and seek diagnosis from an expert; the expert and supplier of treatment may either be the same agent or separate agents, e.g., non-GM food product supplied by a food firm is an example of the former, a food product with low-sodium content the latter, where nutritional scientists acting

as expert(s) advise consumers a low-sodium diet is beneficial, the treatment being supplied by a food firm.

In this section, the focus is on whether it might matter who provides diagnosis in the case of food products with credence attributes. Specifically, two contrasting cases of firms providing the relevant diagnosis are presented: first, reduction of externalities associated with food production where both firms and NGOs may interact as experts in providing a diagnosis to consumers; and, second, firms supplying the treatment, and novel foods and production methods where regulators are potentially subject to capture by expert firms. Motivation for the former draws on the case of Starbucks and how it has collaborated with NGOs on selling and promoting fair-trade coffee beans (Argenti, 2004); the latter draws on the case of aspartame which was eventually approved for commercial release, despite a report by the FDA indicating that the firm G.D. Searle misrepresented the carcinogenic effects of the artificial sweetener and kept back incriminating evidence from the FDA (Iuliano, 2010).

Corporate Social Responsibility, Credence Goods and NGOs

In examining the influence of NGOs in credence good markets, the presumption of Fedderson 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; Siegel and Vitaliano, 2007), i.e., firms engage in an environmentally-friendly production activity that goes beyond what is required by law.

Baron (2009) 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 (2009) 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 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 (2009) 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 (2009) 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 correct diagnosis, the level of which may be affected by external pressure from NGOs who are also acting as experts.

Novel Foods and Production Methods

In many countries, food products that are considered novel due to the product itself, an ingredient, or the food production process, and which may or may not be harmful to consumers, are evaluated by a regulatory agency prior to their commercial release. Obviously if the regulator has perfect information about a novel food that it is presented for evaluation, and also acts in the best interests of the consumer, the diagnosis stage is straightforward, i.e., only safe novel foods will be permitted to be commercially released, the credence good problem collapsing to the treatment stage whereby any claimed benefits of the novel food will be certified and labeled accordingly. Two things militate against this outcome: first, the complexity and extent of innovations means that firms

seeking approval for their novel foods will necessarily be experts at the diagnosis stage; and second, whether or not the regulator is well-informed about novel foods, there is always the possibility that they will be subject to regulatory capture in the approval process. Importantly, if there are economies of scope between the extent of innovation by firms and the degree of influence they can exert over the regulator, there is clear potential for what has been termed "deep" capture of the regulator as distinct from "shallow" capture (Hanson and Yosifon, 2003).

Prior to Stigler (1971), the presumption of "public interest" theory of economic regulation was that a benevolent social planner would behave as a rational actor, their preferences for regulatory outcomes and other economic policy choices being consistent with the public interest. Stigler's (1971) contribution drew from his observation that firms may have an incentive to seek regulation, and that politicians are willing to supply that regulation if it allows them to maintain or augment their power. A problem with this approach is that it applies broadly to a class of political economy problems involving rent-seeking, and is not very specific to the notion of regulatory capture. It also has two key methodological limitations: first, because it ignores informational asymmetries, regulated firms are unable to extract rents, and therefore have no incentive to try to influence regulators, i.e., there is no agency problem; second, the supply side of policies is a "black-box", ignoring the agency relationship between the government and appointed regulator (Laffont and Tirole, 1993).

Introducing an explicit regulatory body in a principal-agent setting allows for the idea that a political principal wants to deal with the possibility that an agent, the firm, may have an incentive to capture the regulator (Bó, 2006). In the credence good setting, a firm in the food industry (the expert) seeks approval of a novel food (diagnosis) from a regulatory body such as the US Food and Drug Administration (FDA). There are two key components in such a setting: first, a firm has

private information about the novel food, so that there is uncertainty about its properties. Due to the fact that consumers may value the innovation, and there is a positive probability that the product is truly novel, it is possible that the contract offered to the firm will allow them to capture rents when in fact the product is not actually novel. Second, because of the information asymmetry, the government has appointed the FDA as regulator (supervisor) whose function is to specialize in learning as much as possible about the extent of the firm's novel product. The problem facing the principal, (government), is that the agent (the firm) has an incentive to "bribe" the regulator (supervisor) into not revealing when their product is not innovative, the amount of the bribe being just equal to the value of the informational rent. Of course actual bribes are typically illegal, but they do not have to be explicit for regulatory capture to occur: financial ties between members of FDA advisory committees, and the firm(s) seeking approval, may bias the recommendations of such committee members in favor of approval of a novel food, even if they have information/concerns about the potential for the novel product to be either unsafe or not be as novel as claimed (Camara and Kyle, 2015). There may also be "revolving doors", whereby regulators may bias their decisions in order to enhance their chances of future employment in the very industry they are regulating. Essentially, the public concern is that there may be a conflict of interest on the part of the regulator (Che, 1995).

Hanson and Yosifon (2003), however, suggest that this is only part of the story - specifically, they make a distinction between "shallow" and "deep" capture. Key to understanding the difference are the concepts of "dispositional attribution" and "situational influences". The former explains behavior in terms of the internal characteristics within an individual, as opposed to situational influences external to that individual. In other words, regulators are not motivated to serve the public interest, rather they are subject to external influences, and therefore subject to

capture. To use the language of social psychologists, the notion of regulators as benevolent social planners is subject to the bias of fundamental attribution error.

Members of advisory committees appointed by regulatory agencies may have incentives to collude with firms from the industry that they are regulating, and this is denoted shallow capture. Specifically, this is assumed to mean that members of advisory committees may learn about the actual safety of novel food products, but due to conflicts of interest, they will not always reveal that information to the regulatory agency, and as a result unsafe food product innovations can enter the market, i.e., the diagnosis and treatment is incorrect.

Deep capture is where firms seek to influence institutions beyond the regulator, including the media, public education and academic research, in order to ultimately influence the broader public. This definition has already found traction in an early application in agricultural economics by Smith and Tasnádi (2014) in their analysis of how the US food industry has attempted to influence the public debate concerning the causes of obesity. Here deep capture is assumed to mean that firms will present biased information in their applications for approval of novel foods in an effort to "nudge" members of the advisory board, and once approved firms will continue to disseminate this biased information in order influence consumers and other groups who maintain an interest in the safety of novel foods.

The regulatory and influence structure is as follows: the government sets the rules for the regulatory body and any advisory committees they employ. For example, a novel food may be presumed unsafe until studies show otherwise, and a standard is then applied for approving that novel food for commercial release. Alternatively, a novel food may be "generally regarded as safe" (GRAS), unless evidence presented suggests otherwise. At this point, it is assumed that the government itself is not subject to capture due to the lobbying activities of the firm, consumers or

other interest groups who may have an interest in the rules and standards applied for approval of novel foods. There is potential for shallow capture of the advisory committees due to members having a conflict of interest, i.e., the committee member may either vote for approval of a novel food product if they have a financial tie to the firm sponsoring that product, or they may vote against approval of that product if they have a financial tie to an incumbent firm with a competing product (Lurie *et al*., 2006).

The advisory committees are also subject to deep capture by the firms whose novel foods they are evaluating for approval. Treating presentation of the information as the diagnosis stage for a credence good, the innovating firm is assumed to be the expert, the innovator knowing more than the advisory committee about its product, i.e., the novel food actually meets claims made about it and is safe. Essentially, innovations are novel by definition, and experts hold asymmetric information about their innovations. As a consequence, food firms expend resources to "nudge" the regulator into approving their novel food product by providing biased information to advisory committee members.

Deep capture occurs because the advisory committee members, given their existing knowledge of food products, and the biased information they receive from firms, are subject to fundamental attribution error when approving novel food products that might actually prove harmful to consumers: they believe they are making the correct decision based on their disposition to act in the public interest when in fact they are subject to situational influence. In addition, the cost of deep capture falls with the extent of innovation by firms, i.e., there are economies of scope between innovation and influence. The more novel a food product, the more complex the diagnosis stage, and the less able advisory committees are able to seek a second opinion and the system is therefore committed to moving to the treatment stage.

Sheldon, Roe and Olimov (2015) consider how members of an advisory committee might be captured by an expert firm. The firm submits data *b* to the regulatory agency concerning the quality and safety of its novel food *i* in application *a*, for which it is seeking approval. The regulatory agency initially conducts an internal review of these data, which it may then refer to an advisory committee of scientists who have some knowledge of the field relating to the novel food. After presentation of these data, the advisory committee members vote for or against approval of the application. The regulatory agency then follows the recommendation of the advisory committee on whether the novel food can be commercially released.

A useful approach to analyzing the voting behavior of members of an advisory committee draws on analysis of the voting behavior of US Supreme Court judges by Iaryczower and Shum (2012), which has been adapted and applied to voting behavior of FDA advisory committees on new drug applications (Camara and Kyle, 2015). An advisory committee is made up of a set of scientists who have to vote on novel food applications. For each application a committee member can vote for or against approval, $\upsilon \in \{0,1\}$, with $\upsilon = 0$ being a vote against, and $\upsilon = 1$, a vote for approval. The advisory committee then aggregates the votes of all committee members by a rule such as majority rule.

Prior to voting on an application, each committee member observes a private signal, $s = \omega + \sigma\psi$, where $\psi \sim N(0,1)$. $\omega \in \{0,1\}$, is an unobservable variable indicating the correct decision about the safety of a novel food, i.e., the correct decision that it is safe $\omega = 1$, and the correct decision that it is unsafe $\omega = 0$. $\theta = 1/\sigma$ is a scale parameter that measures the information content of the signals received by a committee member. Also, $\rho \equiv \Pr(\omega = 1)$ is the common prior probability of state ω.

Each committee member cares about the information contained in the signal, as their payoffs are state-dependent. Specifically, it is assumed that given $\pi \in (0,1)$, a committee member's payoff depends on both the correct decision about a novel food, ω, and their actual vote on the application for approval, υ. Specifically, there are two possible negative payoffs to a committee member if they get the decision about safety of a novel food wrong: first, the cost to a committee member of recommending an unsafe novel food for commercial release is $-\pi$, given that they vote in favor of the application, $\upsilon = 1$, but the correct decision is actually that the novel food is unsafe, $\omega = 0$; second, the cost to a committee member of blocking a safe novel food for commercial release is $-(1-\pi)$, given that they vote against the application, $\upsilon = 0$, but the correct decision is actually that the novel food is safe, $\omega = 1$.

These negative payoffs of making an incorrect decision are adjusted to allow for the possibility of conflicts of interest on the part of the advisory committee member, i.e., there is the potential for shallow capture. If a committee member has a tie to the firm sponsoring an application, SC, they receive λ for voting in favor of the application, and if they have a tie to a competing firm, CC, they receive κ for voting against the application.

Information *E* consists of the private scientific information of the committee member, which is subject to influence by the expert firm through *b*. Assuming initially that there are no conflicts of interest, $\lambda = \kappa = 0$, an advisory committee member will vote in favor of approval of a novel food product if $\Pr(E|\omega = 1) \geq \pi$, i.e., the correct decision is safe. Equivalently, and allowing for conflicts of interest, an advisory committee member will only vote in favor of approval if:

$$\lambda SC - \pi \Pr(E|\omega = 0) \geq \kappa CC - (1-\pi)\Pr(E|\omega = 1).$$

From this model structure, it is possible to make some predictions about the influence of shallow and deep capture on the votes of advisory committee members, and hence the outcome of

committee voting. The parameter π can be thought of as capturing the "ideological" beliefs of a committee member about novel foods. If their beliefs are neutral, $\pi \approx 1/2$, and the common prior is uninformative, $\rho \approx 1/2$, if the information content of the signal is "good", i.e., the scaling parameter θ is high, and there are no conflicts of interest, $\lambda = \kappa = 0$, then advisory committees will come to unanimous decisions, and be evenly split between approving and rejecting novel foods. This is the case where there is neither shallow nor deep capture, i.e., committee members are not subject to bribes, and "good" information is not subject to bias, i.e., the expert firm does not try to convince a neutral committee member that their novel food is actually safe when it is in fact unsafe.

If these assumptions are relaxed individually: first, suppose committee members have strong "ideological" beliefs. For example, suppose the class of novel food is one containing genetically modified (GM) ingredients, and the advisory committee member is either pre-disposed to be in favor of GM ingredients, $\pi \approx 1$, or pre-disposed to be against GM ingredients, $\pi \approx 0$. In this case, individual committee members will exhibit a lower variability in their votes, voting more consistently for or against the novel food; second, if there is shallow capture due to conflict of interest, $\lambda > 0$ and $\kappa > 0$, committee members are more likely to vote for the novel food of a sponsor, and more often vote against the product of a competitor to their sponsor; and third, if the sponsoring firm supplies biased information to committee members via deep capture investments, there will be less variability in their voting, and they will more often vote with the majority in favor of approving novel foods.

In terms of policy implications, there are two obvious steps that governments could take in their approach to the supervisory role of regulatory agencies. The first, which comes directly from the orthodox literature on regulatory capture, is to minimize the impact of conflicts of interest, i.e.,

exclude FDA advisory committee members with a conflict of interest from votes on novel food applications (Lurie *et al*., 2006; Iuliano, 2010). Second, deep capture might be minimized through "taking industry out of safety trials" through independent conduct of safety trials (Iuliano, 2010), e.g., either the regulatory agency itself could act as expert by employing its own scientists to conduct such trials or they could be outsourced to scientists at universities and other research centers. Of course, the cost of the former may be prohibitive, and the latter institutions are themselves open to deep capture by experts.

Summary and Conclusion

As defined by the economics literature, credence goods markets are subject to failure due to consumers being unable to punish fraudulent experts diagnosing and supplying treatment, and because consumers lack the technical expertise with which to verify the quality of treatment actually offered. Surprisingly in agricultural economics, the focus of research has been almost entirely on how labeling and certification of food products containing credence attributes will resolve the problem of consumers being charged for high-quality when in fact they receive low-quality. This ignores the diagnosis stage for credence goods and whether or not it matters which experts provide the diagnosis.

In this context, this review has focused on three areas: the credence good problem as analyzed in the mainstream economics literature; some of the key findings of the extant literature in agricultural economics on credence goods; and how under different circumstances firms acting as experts may provide the correct (incorrect) diagnosis and treatment to consumers of credence goods. The key conclusion to be drawn is that by assuming that consumers know what they want (complex vs. simple treatment), and focusing only on resolution of the asymmetric information

problem, agricultural economics ignores the crucial role that firms, NGOs or government regulatory agencies, acting either independently or jointly as experts, play in the process of diagnosis and treatment in credence good markets. This matters given that experts may either act in good faith in seeking to be socially responsible, or by seeking to influence regulatory agencies, they may provide diagnoses and treatment that are potentially unsafe to consumers.

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