

Baum, Chad M.

Working Paper

Mass-produced food: the rise and fall of the promise of health and safety

Papers on Economics and Evolution, No. 1303

Provided in Cooperation with:

Max Planck Institute of Economics

Suggested Citation: Baum, Chad M. (2013) : Mass-produced food: the rise and fall of the promise of health and safety, Papers on Economics and Evolution, No. 1303, Max Planck Institute of Economics, Jena

This Version is available at:

<https://hdl.handle.net/10419/88260>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

PAPERS on Economics & Evolution



MAX-PLANCK-GESELLSCHAFT

1303

Mass-Produced Food: the Rise and Fall of the Promise of Health and Safety

by

Chad M Baum

The *Papers on Economics and Evolution* are edited by the Evolutionary Economics Group, MPI Jena. For editorial correspondence, please contact: evopapers@econ.mpg.de

ISSN 1430-4716

Max Planck Institute of Economics
Evolutionary Economics Group
Kahlaische Str. 10
07745 Jena, Germany
Fax: ++49-3641-686868

© by the author

Mass-Produced Food: the Rise and Fall of the Promise of Health and Safety

Chad M. Baum¹

Jena Graduate School "Human Behavior in Social and Economic Change", Bachstr. 18k, 07743 Jena, Germany

Max Planck Institute of Economics, Kahlaische Str. 10, 07745 Jena, Germany

Abstract

The greater awareness of the negative environmental and health-related externalities of the large-scale food industry is directly responsible for the diminished confidence of the quality of its products. Using the multi-level perspective on socio-technical transitions (Geels, 2004; 2010), I argue that the initial impetus for the emergence of mass production was the presence of threats to health and safety in the broader societal context. Rather than simply serving economic considerations, the scale and scientific expertise of mass production functioned as a credible signal due to its relationship to these threats. The declining health and safety of the food industry represents, however, a consequence of the changing relationship of scale and quality due to the emergence of new threats to health and safety. Scale as a signal of credibility is no longer sufficient to guarantee these qualities, however. Absent the incentives to undertake costly investments in quality production, the criteria of productivity and efficiency become duly emphasized to the detriment of health and safety. Hence, the continued emphasis on scale now represents a limitation to improving health and safety. Instead, further quality innovation demands the development of a costly signal appropriate to the extant social context.

Keywords: socio-technical transitions; health and safety of the food industry; mass production; credibility

1. Introduction

The industrialization and increasing scale of the food production process has been vital in improving food security. During the latter half of the 19th century in the United States and United Kingdom, the development of a cheap foodstuff of consistent quality was a top priority in light of the emergence of a

¹ Tel.: +49 3641 686 832

E-mail address: baum@econ.mpg.de

sedentary working class due to widespread urbanization and immigration. The advantages of the system of mass production, linked to the mechanization and industrialization of the food industry, were therefore directly relevant to the broader societal context. Reflecting the diminishing salience of starvation, however, the emergence of new challenges and problems such as climate change and the health and safety of food are increasingly salient. The increasing awareness of the negative environmental and health-related externalities of the system of mass production, moreover, reveals a divorce from the previous credibility of the food industry. In light of these concerns, how can the timing of the decrease in the health and safety of mass-produced food be explained? Similarly, in spite of increasing awareness, what is limiting the breakthrough of innovations seeking to improve food quality?

This paper argues that these questions can only be answered by appreciating the impact of the social context. In specific, the influence of broad societal considerations on the definition of what a quality product is and, therefore, on the nature of consumer demand fundamentally structures the direction of innovative activity. Given that health and safety are credence attributes (Darby and Karni, 1973), moreover, the development of a reputation for credibility is central to quality innovation. The social nature of innovation, consequently, also encompasses the formulation of a signal, the credibility of this signal being essential to the stability of a production regime and, conversely, the potential for a transition between regimes. Framed using the multi-level perspective on socio-technical transitions (MLP) (Geels, 2004; 2010), the evolving relationship between mass production and the concerns over health and safety establishes the background of quality innovation. For this reason, an emergent production regime can be characterized as a specific means to reduce the information asymmetry between producers and consumers. The credibility of a signal, and thus its capacity to incentivize costly investments in quality production, is thus strongly dependent on the degree of alignment between the production regime and the salient concerns in the social context.

The importance of signaling for the potential for quality innovation offers a different perspective on the importance of scale in the system of mass production. I argue that the credibility of this regime is contingent on the relevance of the scale and scientific expertise of production to the health and safety demanded by consumers. Drawing parallels between the context in which mass production emerged and the current credibility crisis, I identify the use of scale as a signal of credibility as a fundamental aspect of this production system. The dominant definition of the societal context in which mass production originated therefore remains relevant throughout its evolution. The difficulties of addressing a demand for health and safety distinct from that around which mass production emerged, however, results in the diminishing credibility of this signal. The emergence of novel threats thus requires that producers in the dominant regime undertake costly investments in quality production to re-establish credibility. Absent the

foundation of credibility necessary for quality innovation, however, there is a greater pressure to continue ‘stacking scale on top of scale’ to maximize profits with little consideration for the qualities of health and safety. The declining quality of mass production is therefore a consequence of the diminishing efficacy of scale as a signal of credibility. Consequently, the current difficulty of improving the health and safety of the food industry is due to the absence of a new signal that is both relevant to the current definition of quality and distinct from the dominant production system, that is, mass production.

Section 2 briefly outlines the current situation in the food industry. Noting the misalignment between the social context and mass production, Section 3 describes the importance of the social contextual architecture of innovation. Section 4 then frames the demand for health and safety innovation in the food industry as a socio-technical transition. Section 5 considers how the success of quality innovation hinges on the ability of the firm to differentiate itself by establishing a reputation for credibility. Section 6 establishes the role of scale as a signal of credibility in the emergence of mass production, underscoring the agreement between the demand for health and safety and the goals of product consistency and quality control in this context. Section 7 argues, however, that the changing relationship between scale and product quality has separated this signal from its legacy of credibility, resulting in the declining health and safety of the food industry. The final section concludes and offers implications.

2. Scale Economies and Externalities in the Food Industry

The growing awareness of the negative externalities of the large-scale, industrialized production system is gradually changing consumer perceptions of this system. The current social context is characterized by salient threats regarding the health and safety of consumers, and more generally the potential for climate change and environment degradation. In the United States, for instance, the overweight and obesity rates have climbed to 64.5 per cent and 30.5 per cent, respectively, expressing the social nature of this health crisis (Brownell and Horgen, 2004). The recent documentary “A Place at the Table” (2012) considers how, in spite of the more-than-adequate food supply, the economic, social, and cultural implications of the poor nutritional quality of food, where the prevalence of empty calories and processed food leaves 50 million Americans malnourished. In relation to the environment, industrial agriculture is associated with a host of undesirable consequences including: air pollution, water contamination, the emergence of antibiotic-resistant insects, diminishing soil quality, and serious health consequences for both farmers and

consumers (see Pimentel (2009) for an extensive discussion). As such, the dominant concern in this context is not quantity, but rather the quality of the food supply.²

The importance of quality is also reflected in the increasing incidence of food safety crises. In fact, as recently as the 1970s, the term food safety was absent from public and regulatory discussions (Cooter and Fulton, 2001).³ However, the incidence of food-borne disease outbreaks such as salmonella and e. coli and, more saliently, horrible diseases with difficult-to-forget names like ‘mad cow disease’ (or BSE) and ‘foot-and-mouth disease’ is making the term ‘food scare’ increasingly well-known to consumers. The case of Bovine Spongiform Encephalopathy (‘mad cow disease’) is especially prominent. After the first confirmed case in 1984, the United Kingdom has seen more than 180,000 cattle contaminated with the disease, a total of 4.4 million slaughtered to prevent its spread, as well as a ban on all beef sales to the European Union for ten years (Brown, 2001). The related neurological disorder in humans has killed 166 people in the UK and 44 elsewhere.

The increasing awareness of environmental and health-related externalities, consequently, stands in stark contrast to the previous confidence in the production system (see Knowles et al., 2007 for an extensive discussion in the context of the European food industry). Moreover, it raises concerns over the relationship between this production system and the qualities of health and safety. The lack of attention paid to health, consequently, has been explained by the fact that nutrition was not a fundamental concern in the initial design of this production system, productivity and efficiency instead being highlighted (Traill et al., 2008). As a result, there is an emphasis on the use of artificial, processed ingredients due to their greater consistency and amenability to long-term storage without refrigeration. However, the association between these ingredients and various health and safety concerns is casting the aims of mass production in a new light. For instance, commonplace ingredients of mass production such as high-fructose corn syrup and trans fats have been linked to the prevalence of obesity, diabetes, and other diet-related diseases. The consumption of trans fats, in specific, is estimated to cause about thirty thousand premature deaths a year in the United States, a two percent increase in their consumption increasing heart-disease risk in women of 93% (Gladwell, 2001).

The importance of standardization and product consistency, moreover, also fosters the tendency in mass production to emphasize innovations at the processing stage of production rather than investing in the costs of production. In general, these innovations seek to improve product quality through the application

² The greater appreciation of the functional impact of foods in promoting well-being or reducing the risk of a disease, i.e. ‘functional foods,’ also reflects the importance of food quality (e.g. Roberfroid, 2000).

³ In the political sphere, the growing significance of health and safety in the context of the United States is reflected by the passage of the Nutrition Labeling and Education Act of 1990, mandating nutritional labeling on most foods and, beginning in 2006, the legal requirement to disclose the amount of trans fats.

of scientific and technological methods to the production process that are able to affect food structures, sensory properties, and nutritional values (Earle, 1997).⁴ However, this emphasis on processing technology has a negative impact on nutrition through the removal of essential nutrients. For instance, the processing of brown sugar into white sugar leads to an almost complete loss of calcium, iron, potassium, and niacin, whereas the canning of fresh tomatoes not only substantially decreases levels of vitamin C and beta-carotene, but causes the amount of sodium to increase by 2760% (Smith et al., 2011: 244). For this reason, there is a fundamental limitation on the nutritional quality of these products due to the centrality of food processing in the system of mass production. As such, the recent problems of health and safety are therefore understood as an inevitable consequence of what this system was designed to do.

However, if the system of mass production is a poor fit for the current social context, why is there then a continued emphasis in this direction? What is preventing an alignment between the logic of the dominant production regime and the greater concern over health and safety? In contrast, the food industry is currently pervaded by the greater integration of the supply chain and increasing partnership between, for instance, large-scale retailers and large-scale distributors in pursuit of further scale economies in transport, distribution, and even wholesaling (e.g. Kaufman, 1999). In this manner, the lack of incentive to undertake fundamental changes in the underlying production process in order to improve nutritional qualities can be explained with regards to profits (Earle, 1997: 172). That is, increasing productivity and efficiency in pursuit of further cost reductions is acknowledged as the safest means to maximize profits. The recent structural changes in the food industry, such as the increasing consolidation of firms and the increasing scale of production operations, are thus envisioned as a consequence of this drive toward improving the consistency, productivity, and efficiency at each link of the supply chain (MacDonald and McBride, 2009). Beneath this logic, however, there lies a fundamental assumption regarding the potential for quality innovation. Namely, the competitive pressure on prices results from the perceived difficulty of improving quality, specifically because of a lack of demand for higher-quality goods. Whether or not this is the case, however, depends on the relationship between the production system and the dominant concerns in the social context.

⁴ In relation to food preservation alone, Earle (1997) identifies the influence of scientific expertise through the methods of heat, cold, chemical, dehydration, and mechanical. The last of which includes complicated techniques such as hurdle technology, ultrasound, electric fields, magnetic fields, irradiation, and pulsed light, as well as advances related to storage, transport, and packaging.

3. The Social Contextual Architecture of Innovation

The fact that mass production was not designed to provide nutritional qualities indicates that to address the growing concern over health and safety requires fundamental changes in the production system. Given path dependency in this industry, the breakthrough of such radical innovations is a difficult objective, demanding the coexistence of various factors. Freeman (1991: 221) argues, therefore, that the particular stimulus for a ‘technological revolution’ is the ‘mismatch’ between the radical innovation and “an institutional environment which has been developed to accommodate a very different system of technology.” This description illustrates a broad outline for such a technological revolution, rather than identifying any specific underlying cause. For instance, the eventual breakthrough of a radical innovation, given the changes it requires in the organization of the production system, demands “a complex process of matching and mutual adjustment between pervasive new technologies, the built environment, and the organizational and technological environments” (Freeman, 1991: 229). Further clarifying the nature of this ‘matching’, however, requires a clearer understanding of the nature of these environments, as well as the interaction between socio-institutional context and production system.

The lack of clarity results from the heavy reliance on technological factors in the theoretical framework of techno-economic paradigms (TEP) (Freeman, 1991; Perez, 1985). Specifically, TEP emphasizes the importance of key factors (i.e. generic technologies) and the technological basis of production as the fundamental determinants of industrial evolution. The propagation of these key factors, facilitating scale economies and lower costs, acts as the fundamental driver of the great waves of innovation (i.e. techno-economic paradigms). Furthermore, the establishment of a paradigm is also accompanied by a suitable organization of the production regime, so that this technology is at the heart of both business operations and, relatedly, the direction of innovative activity. The essential nature of technological considerations in industrial evolution mirrors the continued emphasis on scale production and processing technology in the food industry. In addition, the comprehensive influence of technological characteristics on the production regime expresses the inherent difficulty of integrating new qualities, given not only the technical, but also organizational change required (e.g. Dosi, 1984; Freeman, 1991).

Nonetheless, the reliance on technological considerations alone is insufficient to understand the evolution of the food industry. For this reason, the early descriptions of TEP have been criticized for their “deterministic overtones” whereby the representation of innovation has “techno-economic forces doing

the initial *acting* and the socio-institutional framework doing the subsequent *reacting*” (Geels, 2011: 26).⁵ In fact, Perez (2010: 196) has argued that “a technology is not chosen because it is efficient, but becomes efficient because it has been chosen.” More specifically, the deficiency of this approach is a consequence of the failure to account for the pressure exerted by the broad societal context on the evolution of the production. Specific to its significance in the food industry, Fischler (1988) expresses the central function of food in our existence, both social and individual, noting that it is fundamental to our most deeply held cultural and personal beliefs. There is thus a reciprocal influence between the consumption choices of consumers and the evolution of the social context, the growing awareness of health and safety impacting these decisions and becoming of greater relevance as a result.⁶

Furthermore, given that the food industry is “more tightly held in the societal and political web than other industries” (Earle, 1997: 169), the social context is crucial in explaining the potential for fundamental change in the food industry. For this reason, Green and Foster (2005: 664) emphasize the interrelation between technical innovation and innovation in socio-economic arrangements in so-called “sociotechnical systems of provision.” The influence of the societal context therefore orients the evolution of the food industry, providing a potential direction for innovative activity. This influence can be illustrated by an example of how the greater salience of specific societal challenges affects the evolution of the food industry provides clarification. First airing in 1968, the CBS News documentary “Hunger in America” called substantial attention to the near starvation conditions in which ten million Americans were living. The resulting outcry prompted substantial legislative and consumer response, including a re-orientation of federal agricultural policy under Secretary of Agriculture Earl Butz. Urging farmers to “get big or get out,” the problem of food security was resolved, the impetus coming not from technological innovation but a sea-change in public awareness that encouraged a relevant regulatory response. The potential breakthrough of a radical innovation, such as the improvement on the health and safety of the food industry, hence relies on the responsiveness of the existing production regime to the dominant challenges and problems facing our time.

⁵ This is also relevant to the long-standing debate over the degree to which ‘social construction of technology’ is possible, and how much a role government and other ‘external’ influences impact the success of a given technology (e.g. Sabel and Zeitlin, 1985).

⁶ Explaining the evolution of consumer preferences is also crucial to understanding the transformation of the food industry. In specific, the food industry is fundamentally altered by the increasing satiation of the need for nourishment and the resulting need for producers to innovate to maintain market share (Witt, 2001). The relationship between consumer demand and the changing production structure in the food industry requires further analysis; however, for this study, I concentrate on the evolution of the social context as a means by which preference change is effected.

4. The Dynamics of Socio-Technical Transitions

The significance of the relationship between production regime and social context re-conceptualizes innovation in the food industry as a social process. Given both the influence of the broader societal context and the interlocking nature of different sectors in the agri-food industry, the dynamics of health and safety in the food industry is better captured using the multi-level perspective on socio-technical transitions (MLP) (Geels, 2004; Geels, 2011). Building on the discussion of technological revolutions, MLP characterizes socio-technical transitions as the result of “the interplay of developments at three analytical levels: niches (the locus for radical innovations), socio-technical regimes (the locus of established practices and associated rules that stabilize existing systems), and an exogenous socio-technical landscape” (Geels, 2011: 26). The establishment of a new socio-technical regime becomes apparent when *dynamics* at each of the levels “link up and reinforce each other” (Geels, 2004: 916). Underscoring innovation in the food industry as a social process, this paper consequently abstracts from the niche level, instead focusing on the evolving relationship between mass production (the dominant regime) and the concerns over health and safety (an aspect of the current landscape).⁷

The “socio-technical landscape” is here conceived as “an exogenous environment beyond the direct influence of... actors, not only the technical and material backdrop that sustains society, but also ... demographical trends, political ideologies, societal values, and macro-economic patterns” (Geels, 2011: 28). As the overarching context of innovation, the transition between socio-technical regimes depends on the degree of pressure from the landscape, where changes at this level open ‘windows of opportunity’ for the breakthrough of radical innovations (Geels and Schot, 2007: 401). As such, the concerns in the social context orient the direction of innovative activity in the food industry, and the divergence between the salient risks to health and safety and the developed techno-institutional framework represents a fundamental source of tension. The basis of this tension between socio-technical regime and the broader considerations in landscape is crucial to explaining the timing of the decrease of health and safety of mass production. It is important to explicate the foundation of socio-technical regimes, namely what ensures their stability and enables the ‘dynamically stable’ alignment of the sub-regimes comprising socio-technical regimes (Geels, 2011: 28). It should first be noted that socio-technical regimes are substantially broader than the technological production system. These regimes also encompass the cultural, political,

⁷ I In fact, MLP has been criticized for its ‘unilinear’ and ‘unidimensional’ approach that over-emphasizes the importance of niches or treats the socio-technical landscape as a residual concept that lacks sufficient dynamism (Berkhout et al., 2004; e.g. Geels, 2011). On this last point, Geels and Schot (2007) have extended the description of the pathways by which socio-technical transitions emerge, the *timing* and *nature* of which vary according to the development of the regime and the strength of the pressure from the social context. This paper seeks to further explore these two aspects.

scientific, and market factors that support the evolution of this system, appropriate given the complexity of the agri-food system.⁸ As such, a given techno-economic paradigm can be imagined as being nested inside a more comprehensive socio-technical regime.

As a result, the degree of coordination between these various regimes is vital to the stability and persistence of a given system. MLP utilizes Giddens' (1984) structuration theory to explain how regime rules are the "medium and outcome of action ("duality of structure")," the reciprocal influence of rules and actions helping to reinforce an existing system (Geels, 2011: 27). The means of coordination in a regime is therefore envisioned as the "semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical systems" (Geels, 2011: 27). These regime rules, whether conceived as cognitive routines, shared expectations and visions, consumer practices, institutional arrangements, are thus the foundation for the interlocking dynamics of the different sub-regimes.⁹ From this perspective, the regime can be understood as the constellation of forces guided by and reinforcing a specific set of rules and expectations that facilitate communication between relevant actors.¹⁰ As a regime is constituted around specific understandings of consumer demand and definitions of product quality, a socio-technical transition entails substantial behavioral change throughout the supply chain, as well as regarding the consumption habits of individuals.¹¹ The cause of path dependency in a regime is thus the constraining impact of regime rules on the diffusion of innovations regarding, for instance, design specifications, understandings of consumer preferences, or types of regulations and, moreover, the difficulty of establishing new rules.

Hence, the prospect of a socio-technical transition is determined by how well the existing rules and practices of the regime remain relevant to evolving set of challenges and problems. The socio-technical landscape thus plays a consequential role in the selection among potential regime rules. Notably, the greater awareness of the threats to health and safety dominant in a landscape can be expected to directly influence the motivations of consumers. Moreover, greater pressure from the landscape would also cultivate the development of new social relationships built around new sets of rules and expectations necessary for the communication of product quality.¹² The compatibility of these rules and practices, at

⁸ In fact, Geels (2011) notes that a fundamental difference between MLP and TEP is the former's greater emphasis on the details of a specific industry rather than of processes at the level of entire economies.

⁹ In fact, the differential impact of changes at the landscape level on these different sub-regimes might also be a cause for instability between the social context and production regime.

¹⁰ As such, the 'external factors' discussed in Windrum and Birchenhall (1998) can be imagined as the rules and expectations that structure the regime and determine the form of the dominant design, such that the product specification is not the driving force in this process, but simply a consequence of this 'understanding.'

¹¹ Similarly, Green and colleagues (1998) emphasize the importance of meso-level techno-economic factors such as "particular market arrangements and patterns of consumption" on the investment decisions of producers.

¹² MLP conceives of niche production systems, for this reason, as a set of rules and networks to compete with, and perhaps later replace or re-configure, the dominant regime.

the heart of how producers attempt to integrate new qualities into their products, with the changing demands of consumers is therefore fundamental to quality innovation. Therefore, the credibility of communication between producers and consumers is central to determining whether or not the breakthrough of a radical innovation occurs.

5. The Market for Healthier, Safer Lemons

The possibility of improving product quality is contingent on overcoming the information asymmetry owing to the limited ability of consumers to verify product quality. The difficulty of quality verification is especially pronounced in large-scale systems such as mass production. For this reason, the importance of signals was first considered in the context of a one-shot anonymous encounter (e.g. Akerlof, 1970; Spence, 1976). Though evident, it is important to note that higher-quality goods demand higher costs of production, and the profitability of such production requires a price premium. In fact, the potential for quality innovation is further reduced given that this premium needs to be sufficient to compensate for the opportunity costs of not pursuing a ‘fly-by-night’ strategy, namely reducing quality and maximizing short-term profits (Shapiro, 1983; Allen, 1984). However, the premiums needed to make quality production worthwhile are only available after consumers develop an expectation of the product quality of a given firm, assuming such stable expectations are feasible in a given competitive environment. The ability to attain such a premium is therefore contingent on the ability of firms to differentiate themselves from their competitors. Otherwise, consumers are forced to assume all products are of average quality as a result of the potential for other firms to free-ride on these quality investments by imitating the quality claims and signaling mechanisms utilized. *Ceteris paribus*, in spite of any additional investments in product quality, Gresham’s Law predicts that bad quality eventually drives good quality from the market, resulting in a “market for lemons” (Akerlof, 1970).

The context of a one-off exchange is inappropriate for the food industry, however, due to the repetitive nature of food purchases. Nevertheless, in spite of the greater ability to verify the existence of certain qualities, the fundamental limit on quality verification is still present given our consideration of health and safety. These qualities belong to the category of credence attributes, or attributes that are impossible to verify without special access to observe and evaluate the production process, also requiring additional expertise or education even were this access available (Darby and Karni, 1973). Consequently, there is an

inherent information asymmetry regarding health and safety, further aggravated by the distance between field and fork inherent in mass production. The ultimate decision to consume high-quality products therefore relies on the existence of a credible signal to use as the principal determinant of an informed choice (Sproles, Geistfeld, and Badenhop, 1980).

The existence of credibility, however, is the result of more than just investments in the production process. To be sure, credibility first entails the capacity of the production system to be able to provide these qualities, i.e. to have the necessary technical competence. In this respect, the scientific basis of production is essential to quality innovation. However, these sunk costs are only effective in reducing information asymmetry if they are “observable *and* ... specific to the production of quality products” (Shapiro, 1983: 662). In other words, the credibility of a signal relies on two factors: the ability to observe a firm’s investments in the production system; and the relationship between the production system and the definition of quality. Given the increasing distance between production and consumption, the absence of a means to communicate these qualities ultimately restricts consumer learning, making the search for information excessively costly. Consequently, Shapiro (1983) disentangles the additional costs of quality production into two types: per-period production costs and one-time information costs necessary to develop reputations. Especially concerning credence goods, the ability for a firm to differentiate itself from the competition depends on its credentials, namely “an undisputed record of honesty, competence, and determinedness with respect to the quality of supply” (Andersen, 1994: 2). Therefore, credibility is a consequence of the investments made by producers to signal their commitment to quality production.

In their discussion of the ‘market failure’ of nutritional qualities, Smith and colleagues (2011: 240) observe that whether “a particular quality is unobserved by the consumer is a description of a market outcome.” The degree to which a signal is sufficiently credible to allow consumers to verify product quality is a result of the relationship between the societal context and production regime. Extending Shapiro’s discussion, the signal used to communicate product quality needs to be relevant to the challenges salient in the societal context so that there is a definite relationship between the organization of the production system and quality production. Consequently, rather than an isolated signal, the credibility fostered by a reputation is determined by its relevance to the production regime as a whole. Reflecting the ‘duality of structure’ discussed earlier, the potential for quality communication is limited by existing investments in capital stock, and the choice of signal is constrained by past decisions of the firm. In order for a signal to reflect commitment to quality production, it needs to be supported by investments in capital stock, the investments in brand reputations further expressing this commitment. Echoing the discussion of regime rules in MLP, these signals, ‘embedded’ in the organization of the production system, thus represent the means of coordination between producers and consumers in a given socio-technical regime.

A newly emergent regime is thus characterized by a specific solution to the problem of information asymmetry, relevant to the dominant challenge or threat in the societal context and the existing competitive environment. Given the centrality of a specific definition of product, the evolution of a socio-technical regime is thus ever linked to the context in which it originated.

6. Scale as a signal of Credibility

Analyzing the historical origins of mass production is important to understanding its relevance to quality production, as well as its capacity for further innovation. Therefore, it is important to understand the threats salient at the time of the emergence of mass production, as well as the relationship between these threats and the scale and scientific expertise of mass production. Certainly, this context could be characterized by a fundamental concern over the quantity of food available. Nonetheless, a strict emphasis on this concern tends to crowd out other salient considerations. Dovetailing with the growing demand for sanitation and waste services, the increasing size of urban environments aggravated concerns over the impact of zoonotic diseases on food safety, prompting substantial anxiety over food poisoning and food safety at the end of the 19th century (Atkins, 2008; Hardy, 2002).¹³ Due to urbanization and immigration, furthermore, not only did the stress on existing food sources in cities increase, but it also became increasingly difficult to procure food. Consumers were therefore confronted with a choice of maintaining previous consumption habits at substantial cost or accepting the information costs required to develop new habits. The feasibility of this change, however, depended on the food available in urban environments being of adequate quality.¹⁴

The primary outlets for procuring food in cities were the unlicensed street vendors that materialized to satisfy the demand for food. However, the ease with which these vendors could change locations made it difficult to track and monitor the quality of their products. Unable to reduce the threat of free-riding, the strategy of ‘economic adulteration,’ by which producers purposefully attempt to degrade quality and make fraudulent quality claims, became especially viable in this context given the absence of incentives

¹³ The desire to ‘purify’ urban environments of the externalities of animal production promoted the implementation of strict regulation and hygiene requirements that actually led to the unexpected consequence of eliminating urban livestock farming along with the presence of these diseases (Atkins, 2008).

¹⁴ In fact, this threat was so severe that, in the period immediately preceding the advent of mass production, many urban dwellers continued to purchase their food directly from farmers at great expense and inconvenience (Scott, 1997). This is evidence of the limited desire to change consumption habits even at such prohibitive costs due to the lack of adequate food available.

for investing in quality or reputation (e.g. Shapiro, 1983; Allen, 1984). Rather than simply forestalling investment in quality production, however, the absence of a credible signal produced incentives to maximize short-term profits by using cheap substitutes for expensive ingredients. As a result, inadequate control of the production process and the presence of perverse incentives resulted in the widespread threat of food adulteration, ranging from “contaminants or additional ingredients finding their way accidentally into food, to systematic and deliberate substitution of ingredients and addition of dyes or chemicals to disguise the results” (Harvey et al., 2002: 166).¹⁵ The concern over the ‘artificiality’ of food production is also evident in the attention given to the table trials run by Harvey Washington Wiley. Giving ‘doses’ of common preservatives and additives such as borax, benzoate, formaldehyde, sulfites, and salicylates, these ‘poison squad’ studies, and the infamous slogan ‘Only the brave dare eat their fare’, cultivated sufficient awareness to culminate in the passage of the Pure Food and Drug Act of 1906 and the promotion of ‘truth in labeling’ regulation (Lewis, 2002).

In this context, therefore, the primary threats to health and safety resulted from a lack of product consistency and limited control over the production process. In order to ensure the hygienic quality of the food production process, it became essential to improve control over both initial agricultural production and the stages of processing and manufacturing, as well as develop innovations such as canning and freezing to deliver an untainted product to consumers. The lack of scientific knowledge and expertise to accomplish these tasks thus represented the fundamental limitation on quality innovation. Due to the perceived relationship between small-scale production and food adulteration, consequently, the relationship between the characteristics of scale production and health and safety was eminently important in fostering the emergence of the socio-technical regime of mass production. In specific, scale and scientific expertise proved essential in differentiating these firms, especially with respect to the control of the production process and product consistency made possible. Representing some of the most advanced technologies available, the quantified, established standards of mass production provided “the appeal of objectivity” and the indication of having overcome the threat of unintentional food adulteration through “the mechanization of natural reproduction, growth, and decay” (Zachmann and Østby, 2011: 2, 6). The use of industrial chemicals such as disinfectants further promised to ‘sanitize’ the production process and eliminate unintended variability.

As a result, the high initial costs of capital investment were initially sufficient to guarantee product quality, signaling the long-term commitment of firms to quality production and an incentive not to reduce

¹⁵ The ‘art’ of food adulteration included, in the case of ketchup production, the use of fermented tomato waste as an ingredient, as well as replacing tomato with pumpkin or squash pulp. More lethally, the use of toxic substances such as arsenic, mercury, aniline dye, and boric and salicylic acids was widespread to disguise unsanitary production conditions or limit decomposition (Collins, 1993; Harvey et al., 2002).

quality. In foregoing the short-term maximization of profits, the high initial costs of investment required for these highly technical production systems, only (economically) feasible for large quantities, ensured consumers of the long-term stability of these producers. Consequently, the price premiums of quality production, as long-term rents from the investment the production system, depended on their relationship to quality, and quality in this context was finely intertwined with these threats to health and safety. The specific investments selected and the organization of the production system therefore needed, in order to secure these rents, to be able to articulate their relevance to these qualities, their continuing profitability depending on the use of scale as a credible signal to demonstrate commitment to quality production. The consonance between the gains from further investing in the new production process and its ability to signal product quality, expressed by the notion of scale as a signal of credibility, was crucial in the aligning the new regime and landscape and thus orienting the evolution of the production system. As illustrated by in the tomato industry, the existence of a credible signal subsequently triggered innovations such as: the mechanization of canning, invention of pressure cooking, equipment for cleaning and cutting, as well as the cultivation and design of a hybridized tomato suitable for commercial production (Harvey et al., 2002: 160-164). In total, the incentives provided by the use of scale as a signal of credibility fostered a slow transition from the ‘scaled-up kitchen’ to a ‘science in command’ system characterized by an assembly-line organization of production. As a result, pioneering firms like Heinz and Campbell’s witnessed such substantial growth that at the turn of the century, less than forty years after their founding, Heinz’s annual production of tomato ketchup numbered 5 million bottles, while Campbell’s had developed the capacity to produce 40,000 cans of condensed soup a week (Harvey et al., 2002: 160).

Nonetheless, the ability to observe these production systems was challenging. Many firms did make a point of proclaiming their factories open to the general public in order to allow them to observe these conditions.¹⁶ Notwithstanding the potential cost advantages from producing large quantities, however, the realization of these gains, as well as the ability to continue to invest in quality production, depended on the existence of a sufficiently large market. Hence, the ability to limit free-riding also required further innovations in providing costly information. In fact, branding first emerged in this context as a solution to the problem of information asymmetry (Collins, 1993: 108). This innovation provided consumers a means to track companies over time, developing quality expectations in the absence of the direct personal interaction inherent in mass production, while also giving firms ‘ownership’ of all investments that served to establish a reputation with consumers. As the scope of the deficit in scientific expertise slowly declined and the use of both scale production techniques proliferated, the ability for firms to distinguish themselves beyond the costly investments in scale production alone became more important.

¹⁶ Producers such as Heinz and Franco-American Foods made a point of proclaiming their “model kitchens” always open to visitors that wanted to verify their practices (Smith et al., 2011).

The cases of dominant firms like Heinz and Campbell's, consequently, serves to crystallize the growing importance of brand reputations in light of the difficulty of verifying product quality. Namely, producers have the choice of not only investing in capital stock, but also investing in brand reputations consistent with their existing capital stock in order to differentiate their products. As a result, the costliness of national advertising campaigns became significant in demonstrating commitment to quality production amidst the growing stabilization of this socio-technical regime. The familiarity of a national brand reflected the likelihood that this firm would "make investments to secure and develop their brand" (Andersen, 1994: 12). The credibility of a signal therefore relies not only on the development of a brand reputation, but the relevance of the investments in costly information to those in production regime. Consequently, the ability for free riders to imitate these investments is diminished due to the coherence between capital investments and investments in providing costly information.¹⁷ In fact, these technological considerations themselves were often employed to communicate product quality, the presence of control and consistency throughout the supply chain as a sign of the commitment to quality. As a result, "heavy and extensive investments in products and properties, in goodwill and reputation and in marketing methods and retail organization... tended to protect [large-scale producers and retailers] from competition" during the initial establishment of these firms, making it difficult for smaller producers to imitate (Jeffreys, 1954: 97).

The credibility of scale as a signal of quality therefore served as the basis of brand reputations. Organized around the significance of scale and scientific expertise in this context, these brands helped reinforce the relationship between the production system and the qualities then salient. In this manner, the credibility of quality claims was augmented by the 'fullness' of the commitment to quality production. That is, not only the specification of the product, but every stage of the consumption experience served as an opportunity to distinguish these firms. For instance, regarding product consistency, larger companies such as Heinz and Campbell's took great efforts to ensure that farmers followed specified cultivation procedures, distributing the seed technology to be utilized and promising to purchase the entire crop produced (Harvey et al., 2002: 160-1). In addition, drawing strength from the salient concerns in the social context, the marketing efforts of firms frequently emphasized the purity and whiteness of both spokespeople and workers.¹⁸ In the case of the fast-food chain White Castle, the prevalence of white hammered home the importance of purity in the brand's image, whether covering the walls of the restaurants, adorning the uniforms of employees, or even the name itself. In fact, the centrality of standardization extended not just

¹⁷ For instance, when confronted with a situation of selecting among 1,000 brands of canned peaches and 10,000 brands of wheat flour, as was the case in the United States in 1928 (see Carsky et al., 1998 for discussion), the existence of a brand is far less important than the familiarity that consumers with what it signifies.

¹⁸ Such was the depth of the commitment of the major brands to these values that the goals of standardization were often accompanied by undertones of social standardization and the fulfillment of democratic principles (Harvey et al., 2002: 193).

to the production methods, but also the use of the same white uniforms and the same prefabricated restaurant environments throughout the chain (Harvey, Quilley, and Beynon, 2002).

In fact, the signaling of this commitment can be strong enough to attain price premiums even in absence of a supporting regulatory environment, so long as the relationship to the salient considerations of a societal context remains apparent. For instance, though unable to successfully legislate against the use of benzoic acid as a preservative, the success of Heinz in communicating the connection between their production system and product quality, symbolized by the slogan ‘Good Ketchup needs no Drugs,’ established a ‘moral high ground’ that forced their competitors to abandon the use of preservatives (Harvey, Quilley, and Beynon, 2002: 167). The success of this ‘pure food’ campaign enabled this company to charge 25-30 cents a bottle compared with the 10-12 cents of their rival. As a result, even though the ability to provide a given quality to consumers is beyond the capacity of a single firm (e.g. Giraud-Heraud et al., 2012), the strength of the relationship between production regime and a specific societal context can help attain the price premiums necessary for quality innovation even in the context of an unfriendly regulatory environment.¹⁹

7. The Detriments of Stacking Scale on top of Scale

In order to understand the anxiety over the health and safety of the food industry, it is important to acknowledge the role of scale as a costly signal in the initial emergence of mass production. In contrast to the common emphasis on scale economies for purely economic reasons, it has been demonstrated how the scale of production was also significant due to its compatibility with the salient threats to health and safety. By promoting quality innovation in this direction, the ongoing evolution of the production system therefore continues to be responsive to the initial problems that this system emerged to solve: the presence of an insufficient food supply to consumers and the inadequate control of the production process. The current deficit in health and safety does not, therefore, reflect an incommensurability between mass production and the goal of improving health and safety. Rather, partly a product of the success of mass production, the minimum level of quality has increased, shifting the priorities of quality production. The

¹⁹ Giraud-Heraud et al. (2012) investigate whether a single firm’s level of investments could reduce the potential for a food scare and thus improve food safety. They conclude that, given the difficulty of distinguishing itself, no level of firm investments significantly reduces this probability, thereby eliminating the rationale for undertaking such costly investments. However, perhaps this result is driven by neglecting to consider the underlying relationship between product quality and production regime.

fact that the continuing credibility of a signal depends on its being “specific to the production of quality products” (Shapiro, 1983: 662), however, presents a challenge to this regime. For this reason, the increasing incidence of food scares and the emerging concern over diet-related diseases such as obesity and diabetes is directly consequent on the incompatibility of the rules and practices of the regime to address the salient concerns evident in the landscape. That is, attuned to, but subsequently divorced from, a context subject to the threat of food adulteration, the goals of cost, consistency, and the ability to preserve products over long distances are over-emphasized. The ongoing stability of the co-evolutionary relationship between regime and landscape therefore depends on the ability of a signal to remain costly in spite of changes in the definition of quality.

Emphasizing the significance of quality control and product consistency, Earle (1997) argues that the application of ‘process engineering knowledge’ to facilitate greater control of the relationships between process variables and product qualities represents a general template for continued quality innovation. Moreover, responding to the greater demand for assurance in the food industry, Andersen (1994: 32) argues that these quality can be ensured by lengthening the supply chain and “insert[ing] several layers of quality control and product selection into the vertical stream of deliveries” between the consumer and the primary producer. Despite the growing distrust of this system, the greater demand for information can be addressed through efforts such as “the invention of new measurement techniques, the establishment of information and control systems..., and the invention of new forms of credentials” (Andersen, 1994: 47)-- in other words, without fundamental change to the production system. Hence, scale as a signal of credibility still represents a template for addressing both the inherent information asymmetry of this system and the growing uncertainty regarding product quality.

However, Andersen (1994: 12) also remarks that the increasing prevalence of a given production process allows “low-quality sellers [to] mimic the credentials of high-quality sellers in a way which makes it impossible for the buyer to discern between them.” Given that free-riding sellers will behave as if they have invested in control systems, high-quality sellers will have to, keeping with the emphasis on control and consistency, distinguish themselves by formalizing the control of their product systems or further standardizing their product designs (Andersen, 1994; Andersen and Philipsen, 1998). Nevertheless, the authors themselves note the further systemization of control systems by high-quality producers makes them easier to imitate; moreover, further product standardization enables the exploitation of the part of the product design that consumers take for granted. Therefore, those firms seeking to produce high-quality products need to either invest again in developing credible signals or, conversely, give up producing high quality.

Moreover, as reflected by the negative externalities of scale production, the use of scale as a signal of credibility is no longer sufficiently specific to quality production to guarantee the price premiums necessary to incentivize investment. Therefore, scale is central to not only the evolution of the production system, but also the divergence between social context and production system, its efficacy as signal no longer sufficient to align them without a fundamental change in production techniques.²⁰ In specific, even though no longer consistent with the qualities salient in the socio-technical landscape, the continued application of the fundamental rules defining this regime, i.e scale and scientific expertise, expands the divergence between the production system and the social context. The lack of will to engage in quality innovation noted by Earle (1997) is thus not simply a matter of existing infrastructure and technical competencies, but rather reflects the inability of the rules and expectations of this regime to be credible in addressing the salient concerns to health and safety. Consequently, the re-establishment of a foundation for quality innovation requires the development of a production system relevant to these qualities so that these investments can be used as credible signals. Redressing the concerns over health and safety, therefore, depends on the establishment of a new costly signal, one that differentiates itself from the dominant production system and its problems much as mass production first did. The current limitation on innovation regarding health and safety is therefore the continued reliance on scale as a signal of credibility, and the absence of a competing signal that can act as the basis of quality innovation.

As such, the ‘demise’ of mass production is hastened along by continuing to ‘stack scale on top of scale’ although no longer relevant to product quality. The specific timing of the declining quality of mass production is a consequence of the greater prioritization of productivity and efficiency as the best means to maximize profits. With respect to innovation regarding health and safety, the continued investment in scale production and process control is therefore a ‘medium-term strategy,’ a term utilized to draw parallels to the short-term strategies prevalent in a market for lemons. In specific, this strategy seeks to maintain initial investments in brand reputations and production technology, while using subtle changes to the established trajectories to maximize profits without undertaking investments that substantially deviate from the established paradigm. Recalling Shapiro’s (1983) equation of price premiums with rents to reputations, the one-time nature of these investments indicates that firms will want to exploit them as long as possible, there being no incentive to undertake costly investments that do not have a direct impact on profits, especially when there is still some residual credibility in these claims.²¹ Moreover, insofar as

²⁰ Furthermore, as a corollary of the impact of the changing relationship between scale and health on quality innovation, the cyclical nature of this process would imply the tendency for overall quality to rise and fall around a secularly increasing trend throughout the evolution of the food industry.

²¹ This also illustrates why firms with established reputations are still willing to invest in providing costly information about product quality along these lines. These investments continue to protect these firms from the competition of lower-quality firms. What is more, with qualities such as convenience, and even freshness and taste more recently, that are conducive to this production system, the potential for quality innovation still remains viable.

these investments demand the foregoing of profits attained through the greater efficiency and productivity of the existing production system, their feasibility decreases even further.

The evolution of the fast food industry provides a specific example of the consequences of continuing to stack scale on top of scale. Mirroring the importance of scale in fostering the emergence of mass production, Gladwell (2001) illustrates how the considerable care for product quality, sourcing specific potato varieties, and the extensive scientific practice characterizing the McDonald's production process allowed it to provide "the finest mass-market fries ever made."²² The consonance between the definition of quality in the social context and the characteristics of the production system fostered the incentives necessary to invest in quality innovation. In describing the dual emphasis on quality and consistency in the selection of ingredients, Ray Kroc, the founder of McDonald's, once wrote: "The French fry would become almost sacrosanct for me, its preparation a ritual to be followed almost religiously." Over time, however, the greater difficulty of addressing the changing demands for health and safety in the food industry, whether unexpected or self-inflicted, foment the greater importance of costs and prices as the basis of competition. Concerning the production of French fries, for instance, the preparation method of deep-frying proved ideal to enrich the carbohydrates of potatoes with fat in providing the texture demanded by consumers. However, when vegetable oil, selected as a chemically stable, low-cost substitute for butter, is hydrogenated to be suitable for deep frying, it results in the production of trans fats. The severe consequences of this for health and safety have already been discussed.²³

The increasing pressure on production costs is further aggravated by the strategy of increasing the length of the supply chain to ensure product quality. In specific, integrating further links in the chain increases the need for profits at each step, whether to pay certifiers, distributors, or wholesalers, etc., and therefore creates further pressure to reduce input costs. The relationship between scale production, national-level brand reputations, and product quality thus continues to diminish over time (e.g. Hjorth-Andersen, 1991; Murphy, 2002). Consequently, lengthening of the supply chain in this manner might be able to provide more information, but it is not necessarily relevant to product quality.²⁴ More significantly, past investments into technology in order to improve the consistency of this product and control over the supply chain have made it essential to differentiate the product at the processing level, integrating the attributes desired by consumers and relying on advertising and marketing to communicate these

²² In fact, the extensive care taken to locate and breed the ideal potato for production mirrors the events described by Harvey and colleagues (2002: 160-3) to "develop the perfect tomato for tomato soup production."

²³ Another perverse outcome of the emphasis on consistency and control is that the artificial strawberry flavoring in milkshakes is comprised of forty ingredients, not one of which is actual strawberries (see Storrar, 2006).

²⁴ The proliferation of in-house brokerage systems (IHBs) serves as an example. As another layer of quality control, retailers outsource the selection of potential suppliers to firms specializing in this task. However, due to the primacy of scale, the main selection criteria for suppliers is "not primarily on the basis of product quality, price, and service, but first and foremost on whether they will sell through a particular IHB" (Marion, 1998: 92).

differences. As a result, however, there is a diminished importance of the initial inputs into this production process, both from the emphasis on standardization and the growing control of processors and retailers over the supply chain. The effect in the agricultural sector has been to drive out smaller farmers unable to attain the necessary productivity and efficiency, the farm share of the food dollar decreasing from 30.9% to 15.8% over the last thirty years as a result (Elitzak, 1999; Canning, 2011).

By diminishing the possibility for profits in this sector, moreover, there is a further knock-on effect regarding the prioritization of cost and efficiency over product quality. To reiterate, this is not due to the low demand for quality, but rather the conditions established and product specifications required by which farmers are forced to operate, for instance, the scale of production necessary and the type of technology to be utilized. The subsequent downward pressure on profits and limited potential for value-added thus reduce the incentive for farmers to invest in additional quality. What is more, as a result of the diminished efficacy of scale as a signal of credibility, there are increasing incentives to maximize short-term profits by further reducing product quality. The growing industrialization of livestock production, exemplified by concentrated animal feeding operations (CAFOs), serves to crystallize the decreasing emphasis on production costs due to the ‘unhinged’ emphasis of scale. In these production systems, a large number of animals are confined in relatively small places with no access to vegetation, kept healthy by antibiotics, while organization is maintained by a combination of machinery and low-cost labor. These operations have been linked to: the increasing incidence of disease epidemics and antibiotic resistance (Gilchrist et al., 2007); health risks to workers and consumers (Heederik et al., 2007); and diminishing water quality (Burkholder et al., 2007). With regards to food scares, moreover, the desired speed of production, and resulting concentration of operations ensures that a single contaminated specimen can quickly proliferate, thereby affecting thousands of consumers. Rather than a stable template for quality innovation, the intensification of scale in the food industry reflects the mismatch between scale as a signal of credibility and the extant definition of quality in the current food industry. Moreover, the examples discussed illustrate the importance of scale as a signal of credibility at the core of mass production and the declining health and safety of the food industry

8. Conclusion

The use of a signaling perspective helps resolve many puzzles in the food industry. First, it provides answers to the two questions lodged in the introduction. What explains the timing of the decrease in the health and safety of mass-produced food? And given these concerns, what is limiting the breakthrough of innovations in the food industry seeking to improve these qualities? Using the multi-level perspective on socio-technical transitions (MLP), I argue that the initial impetus for the transformation of the food industry is the salience of new threats to health and safety that characterizes the evolving social context. The direct cause of the declining health and safety, however, is the changing relationship between the system of mass production and the definition of product quality, rendering scale ineffective as a signal of credibility and no longer sufficient to guarantee these qualities. Absent the incentives to undertake costly investments in quality production, the criteria of productivity and efficiency become duly emphasized to the detriment of health and safety. As a result, the factor limiting the breakthrough of radical innovations regarding the health and safety of the food industry is the continuing emphasis on scale production and scientific expertise. I have argued that this reflects the enduring credibility of scale as a signal of quality, transmuted into a confidence in the central importance of productivity and efficiency in the food industry.

The changing efficacy of a signal, such as that of scale production, is therefore an outcome of the vagaries of the co-evolutionary relationship between the production system and social context. The potential for a socio-technical transition can thus be characterized by the width of the gap between the socio-technical regime and socio-technical landscape. This framework is therefore useful to explore the substantial changes in the agri-food socio-technical regime and the emergence of new sources of uncertainty. The growing perception of, for instance, “dread risk” presents a challenge to quality innovation. In specific, the “perceived lack of control, dread, catastrophic potential, fatal consequences, and the inequitable distribution of risks and benefits” is increasingly prevalent in the food industry with the introduction of technologies such as genetically modified foods and nanotechnology (Slovic, 1987: 283). In spite of their obvious novelty, these technologies can be viewed as an extension of the signaling mechanism of the existing paradigm. It has been remarked that the scientific expertise embedded in ‘nano-foods’ offers the prospect of increasing health and safety by being able to monitor and track each product throughout the supply chain, also offering real-time information related to potential disease outbreaks (Scriniis and Lyons, 2007). Specific to GMOs, there is also the promise of a greater control of product quality through the potential of making modifications at the atomic and molecular level.

In consequence, this casts a new light on the (re-)emergence of alternative supply chains such as small-scale independent retailers, farmers' markets, and community supported agriculture. Given their distinctiveness from mass production and the perceived relationship between this signal and product quality, the role of small-scale production systems as a costly signal for product quality presents food for thought in the current regulatory climate. This is especially pertinent amidst the credibility crisis facing this system due to the recent scandals involving horse meat in beef products and e. coli in sprouts.²⁵ As a niche, moreover the small-scale production systems satisfy the requirement of offering innovation regarding rules and expectations (Geels, 2004). In this respect, local agriculture and farmers' markets cultivate a definite relationship between not only producer and consumer, but also between consumers and the source of production. Given the radical differences between the organization of these systems and mass production, moreover, it seems difficult to picture the eventual reconciliation predicted by Geels and colleagues. Rather, the distinct approaches to attaining credibility might provide an explanation for why the food industry is 'characterized by *multiple* 'green' niche-innovations (Geels, 2010: 507). That is, the expansion of qualities demanded by consumers could require a further specialization of production techniques to achieve the credibility necessary for certain quality claims. Exploring the rejuvenation of the Co-op movement, consequently, Sodano and Hingley (2009) demonstrate that, rather than imitating their 'investor-oriented' competitors, these alternative formats remain competitive by maintaining their distinctiveness, specifically as regards the rules of democracy and mutuality. This distinctive organizational structure, by enabling more long-term partnerships with local producers, offers a comparative advantage difficult for mass producers to replicate.²⁶

Moreover, the relationship between credibility and consumer learning in these different regimes needs to be clarified. This is especially true given the additional demands on consumers due to the proliferation of credence attributes and the greater awareness of the relationship between food consumption and well-being. Beyond "the past emphasis on survival, hunger satisfaction, and preventing adverse effects," the importance of "functional foods" that have a "physiologic or psychologic effect beyond the traditional nutritional effect" is increasingly observed, whether in promoting well-being or reducing the risk of a disease (Roberfroid, 2000: 1660-1S). The nature of a connection between the different rules and expectations articulated in these alternative production regimes and the evolution of consumer demand therefore needs to be explored further. Again, the strength of this credibility is reliant on the ability of

²⁵ Demonstrating their relevance in this context, though almost nonexistent before 1990, the number of CSAs has nearly doubled since 2004, now numbering more than 4,000 with the number of participating households greater than 0.5 percent of all households in the United States (Local Harvest, 2010; 2011).

²⁶ Also interesting is that the original Co-op movement emerged in the middle of the 19th century, partly in response to the threat of food adulteration. Given the salience of other motivations at that time, such as convenience, variety, and hunger, its additional credibility regarding health and safety seemingly proved a poor fit to the time, but perhaps no longer.

producers to establish a costly signal and prevent free-riding. Insofar as these small-scale regimes are effective in doing so, their increasing prevalence reflects a possible foundation for the re-alignment with the social context, and therefore a basis to understand the changing relationship between consumers and the food they eat.

Acknowledgements

This work has been supported the Federal Programme “ProExzellenz” of the Free State of Thuringia. My sincerest gratitude to Professor Ulrich Witt, Professor Uwe Cantner, Leonhard K. Lades and Andre Grimes for valuable suggestions and comments. The usual caveats apply.

References

- Akerlof, G.A. (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. *The RAND Journal of Economics*, 15(3): 311-327.
- Andersen, E.S. (1994). The evolution of credence goods: A transaction approach to product specification and quality control. *MAPP Working Paper 21*, Programme on Market-based Process and Product Innovation in the Food Sector, Aarhus, Aarhus School of Business.
- Andersen, E. and Philipsen, K. (1998). The Evolution of Credence Goods in Customer Markets: Exchanging “Pigs in Pokes”. Paper presented at the DRUID Winter Seminar, *Middelfart*, Denmark.
- Atkins, P. (2008). Fear of animal foods: A century of zoonotics. *Appetite*, 51(1): 18-21.
- Berkhout, F., Smith, A., and Stirling, A. (2004). Socio-technological regimes and transition contexts. In: B. Elzen, F.W. Geels and K. Green (Eds.). *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy*. Edward Elgar, Cheltenham, pp. 48-75.
- Brown, D. (2001). The 'recipe for disaster' that killed 80 and left a £5bn bill. *The Daily Telegraph*. <http://www.telegraph.co.uk/news/uknews/1371964/The-recipe-for-disaster-that-killed-80-and-left-a-5bn-bill.html> (3/12/2012).
- Brownell, K. D. and Horgen, K. B. (2004). *Food Fight*. New York: McGraw-Hill.
- Burkholder, J., Libra, B., Weyer, P., Heathcote, S., Kolpin, D., Thorne, P. S., and Wichman, M. (2007). Impacts of waste from concentrated animal feeding operations on water quality. *Environmental Health Perspectives*, 115(2): 308-312.

- Canning, P. (2011). A Revised and Expanded Food Dollar Series: A Better Understanding of Our Food Costs. Economic Research Report-114, USDA Economic Research Service. <http://www.ers.usda.gov/Publications/ERR114/ERR114.pdf> (10/5/2011).
- Carsky, M.L., Dickinson, R.A., and Canedy, C.R. III (1998). The Evolution of Quality in Consumer Goods. *Journal of Macromarketing*, 18(2): 132-144.
- Caswell, J.A., (1998). How Labeling of Safety and Process Attributes Affects Markets for Food. *Agricultural and Resource Economics Review*, 27(2): 151-158.
- Collins, E. (1993). Food adulteration and food safety in Britain in the 19th and early 20th centuries. *Food Policy*, 18(2): 95-109.
- Cooter, R. and Fulton, R. (2001). Food matters: food safety research in the UK public sector, 1917-1990. *Food Industry Journal*, 4(3): 251-261.
- Darby, M. and Karni, E. (1973). Free competition and the optimal amount of fraud. *Journal of Law and Economics*, 16(1):67-88.
- Dosi, G. (1984). *Technical Change and Industrial Transformation: the theory and an application to the semiconductor industry*. London: Macmillan.
- Earle, M.D. (1997). Innovation in the food industry. *Trends in Food Science and Technology*, 8(5): 166-175.
- Elitzak, H. (1999). Food Cost Review, 1950-1997. *Agricultural Economics Reports*. USDA Economic Research Service. <http://ageconsearch.umn.edu/handle/34053> (10/9/2010).
- Fischler, C. (1988). Food, self and identity. *Social Science Information*, 27(2): 275-292.
- Freeman, C. (1991). Innovation, Changes of Techno-Economic Paradigm and Biological Analogies in Economics. *Revue Economique*, 42(2): 211-232.
- Geels, F.W. (2004). From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. *Research Policy*, 33: 897-920.
- Geels, F.W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research Policy*, 39: 495-510.
- Geels, F.W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, 1:24-40.
- Geels, F.W. and Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, 36:399-417.
- Giddens, A. (1984). *The Constitution of Society: Outline of the Theory of Structuration*. Berkeley: University of California press.
- Gilchrist, M. J., Greko, C., Wallinga, D. B., Beran, G. W., Riley, D. G., and Thorne, P. S. (2007). The potential role of concentrated animal feeding operations in infectious disease epidemics and antibiotic resistance. *Environmental Health Perspectives*, 115(2): 313-316.
- Giraud-Heraud, E., Hammoudi, Abdelhakim, Hoffmann, R., Soler, L-G. (2012). Joint Private Safety Standards and Vertical Relationships in Food Retailing. *Journal of Economics and Management*, 21(1): 179-212.
- Gladwell, M. (2001). The Trouble with Fries: Fast Food Is Killing Us. Can It Be Fixed?. *The New Yorker*, 5: 52-57.
- Green, K., Hull, R., Walsh, V., and McMeekin, A. (1998). The Construction of the Techno-Economic: Networks vs. Paradigms. *CRIC Discussion Paper 17*, Centre for Research on Innovation and Competition, The University of Manchester.

- Green, K. and Foster, C. (2005). Give peas a chance: transformations in food consumption and production systems. *Technological Forecasting and Social Change*, 72(6):663–679.
- Hardy, A. (2002). Food, Hygiene, and the Laboratory. A Short History of Food Poisoning in Britain, circa 1850–1950. *Social History of Medicine*, 12(2): 293-311.
- Harvey, M., Quilley, S., and Beynon, H. (2002). Exploring the Tomato: Transformations in Nature, Economy and Society. Cheltenham: Edward Elgar.
- Heederik, D., Sigsgaard, T., Thorne, P. S., Kline, J. N., Avery, R., Bønløkke, J. H., ... and Merchant, J. A. (2007). Health effects of airborne exposures from concentrated animal feeding operations. *Environmental Health Perspectives*, 115(2): 298-302.
- Hjorth-Andersen, C. (1991). Quality Indicators: in theory and in fact. *European Economic Review*, 1491-1505.
- Jeffreys, J.B. (1954). *Retail Trading in Britain. 1850-1950*. National Institute of Economic and Social Research, Economic and Social Studies, XII. Cambridge: Cambridge University Press.
- Kaufman, P. (1999). Food retailing consolidation: implications for supply chain management practices. *Journal of Food Distribution Research*, 30: 5–11.
- Knowles, T., Moody, R., and McEachern M.G. (2007). European food scares and their impact on EU food policy. *British Food Journal*, 109 (1): 43-67.
- Lewis, C. (2002). The “Poison Squad” and the Advent of Food and Drug Regulation. *FDA Consumer*, 36(6): 12-15.
- Local Harvest (2010). "CSA by the Numbers." January 2010 Newsletter. Online. <http://www.localharvest.org/newsletter/20100128/> (5/10/2011).
- Local Harvest (2011). Community Supported Agriculture. Online. <http://www.localharvest.org/csa/> (5/9/2011).
- MacDonald, J. M., and McBride, W. D. (2009). The Transformation of U.S. Livestock Agriculture: Scale, Efficiency, and Risks. Economic Information Bulletin-43. USDA Economic Research Service. http://www.agmanager.info/about/contributors/Presentations/Langemeier/MacdonaldMcbride_2009.pdf (15/12/2012).
- Marion, B. (1998). Changing power relationships in the US food industry: Brokerage arrangements for private label products. *Agribusiness*, 14(2): 85-93.
- Murphy, D. (2002). Price and quality relationships in local service industries. FTC Bureau of Economics Working Paper No. 249. <http://ssrn.com/abstract=387882> (24/1/2012).
- Perez, C. (1985). Microelectronics, long waves and world structural change: New perspectives for developing countries. *World Development*, 13(3): 441-463.
- Perez, C. (2010). Technological revolutions and techno-economic paradigms. *Cambridge Journal of Economics*, 34(1): 185-202.
- Pimentel, D. (2009). Environmental and economic costs of the application of pesticides primarily in the United States. *Integrated Pest Management: Innovation-Development Process*, 89–111.
- Roberfroid, M.B. (2000). Concepts and Strategy of Functional Food Science: the European Perspective. *The American Journal of Clinical Nutrition*, 71: 1660S-1664S.
- Sabel, C.F. and Zeitlin, J. (1985). Historical Alternatives to Mass Production: Politics, Markets, and Technology in Nineteenth-Century Industrialization. *Past and Present*, 108: 133-176.

- Scott, P. (1997). Large-scale retailing in Britain, 1850-1914. *Refresh*, 24: 5-8. Economic History Society. <http://www.ehs.org.uk/ehs/refresh/assets/Scott24b.pdf> (30/1/2012).
- Scrinis, G. and Lyons, K. (2007). The Emerging Nano-Corporate Paradigm: Nanotechnology and the Transformation of Nature, Food, and Agri-food Systems. *International Journal of Sociology of Food and Agriculture*, 15(2): 22-44.
- Shapiro, C., (1983). Premiums for High Quality Products as Returns to Reputations. *The Quarterly Journal of Economics*, 98(4): 659-79.
- Slovic, P. (1987). Perception of Risk. *Science*, 236(4799): 280-285.
- Smith, T.G., Chouinard, H.H., and Wandschneider, P.R., (2011). Waiting for the invisible hand: Novel products and the role of information in the modern market for food. *Food Policy*, 36(2011): 239-49.
- Sodano, V. and Hingley, M. (2009). Innovation in food networks and organizational diversity: a case study from the UK retail cooperative sector. Paper presented at the 3rd International European Forum on System Dynamics and Innovation in Food Networks, Innsbruck-Igls, Austria, from February 16-20, 2009.
- Spence, A.M. (1976). Informational Aspects of Market Structure: an Introduction. *The Quarterly Journal of Economics*, 90(4): 591-597.
- Sproles, G.B., Geistfeld, L.V., and Badenhop, S.B. (1980). Types and amounts of information used by efficient consumers. *Journal of Consumer Affairs*, 14(1): 37-48.
- Storarr, K. (2006). 59 Ingredients in Strawberry Milkshake- But no Strawberries. *The Daily Mirror*. <http://www.mirror.co.uk/news/uk-news/59-ingredients-in-strawberry-milkshake---622350> (4/2/2013).
- Traill, W.B., Arnoult, M.H.P., Chambers, S.A., Deaville, E.R., Gordon, M.H., John, P., Jones, P.J., Kliem, K.E., Mortimer, S.R., and Tiffin, J.R. (2008). The potential for competitive and healthy food chains of benefit to the countryside. *Trends in Food Science and Technology*, 19(5): 248-254.
- Windrum, P. and Birchenhall, C. (1998). Is product life cycle theory a special case? Dominant designs and the emergence of market niches through co-evolutionary learning. *Structural Change and Economic Dynamics*, 9(1): 109-134.
- Witt, U. (2001). Learning to Consume—A Theory of Wants and the Growth of Demand. *Journal of Evolutionary Economics*, 11(1):23–36.
- Zachmann, K. and Ostby, P. (2011). Food, technology, and trust: an introduction. *History and Technology: An International Journal*, 27(1): 1-10.