

**Alternative Firm Strategies for  
Signaling Quality in the Food System**

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**Abstract**

Dynamics in the global food system, coupled with rapid advance in agricultural biotechnology, have resulted in additional demands for capturing information and sharing information vertically within the supply chain. Food safety and quality characteristics are a cornerstone of this information demand. Events such as foot-and-mouth disease (FMD) and bovine spongiform encephalopathy (BSE), genetic engineering, and animal welfare concerns have laid the foundation for additional information need.

Managers of private firms within the food supply chain must decide how to respond to the situation. A crucial component of the problem is what and how to provide information to downstream customers as well as stipulate what and how information is received from upstream suppliers. Alternative signaling mechanisms abound. The choice among these alternative signals, or combination of alternatives, has both short- and long-run implications for the reputation of the firm, its products or services, and the efficiency with which it conducts its business. The signaling problem in the supply chain is bi-directional and has three critical dimensions: information asymmetry, incentive asymmetry, and arduous measurability. From a broad perspective, the choice set for signaling includes: strategies that rely on third-party protocols and procedures; differentiation through branding and reputation; indemnification strategies such as insurance, warranties, and bonding; coordination strategies such as strategic alliances and vertical integration (internalization). Each mechanism for signaling differentially influences the three dimensions of the signaling problem. No globally optimal strategy solution exists. Differentiation through branding and reputation mitigate the signaling problem relatively well compared to the other alternatives.

**Keywords:** Identity preservation, traceback, signaling strategies, quality, food system



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## **Alternative Firm Strategies for Signaling Quality in the Food System**

Numerous events have developed rapidly within the global food system that conspire to build demand for increased vertical information flow. These events center primarily on genetic engineering and food safety. However, demand has arisen for additional vertical information on quality, not related to genetic engineering or safety, such as animal welfare.

To illustrate with regard to food safety, both foot-and-mouth disease (FMD) and bovine spongiform encephalopathy (BSE) are influencing European agriculture and have become a topic of conversation around the world. Occurrence of these diseases in Britain caused concern among consumers worldwide. The economic wake of these food safety events extend not just to Britain's economy, but have influenced trade and tourism. Both affect livestock product prices, availability of goods, and costs of production. Governments also restrict imports from infected countries; hence trade is affected.

A similar episode occurred with corn in the United States. Sold by Aventis CropScience, StarLink™ corn is engineered to contain the Cry9C protein obtained from *Bacillus thuringiensis* (Bt), a genetically engineered variety. StarLink™ corn, because of questions about the allergenic potential of the Cry9C protein, was not approved for use in foods intended for human consumption (Washington Post, 2000). Taco Bell brand taco shells, sold in the U.S., tested positive for StarLink™ corn. A recall followed. In general, genetic engineering has created an array of demands for enhanced information, including labeling of foods containing genetically engineered material (Caswell, 1998).

Vertical information flows are unambiguously important in responding to the call for improved animal welfare. Animal welfare concerns have become more prominent both in the

U.S. and the EU. Moynagh reports on EU legislation that attempts to “...ensure improved protection and respect for welfare of animals...” across all species of meat animals (Moynagh, 2000). Information on certain husbandry practices, such as pen size or slaughter conditions, becomes key in this demand for increased information flow from upstream to downstream market channel segments.

Managers of private firms within the food supply chain must decide how to respond to the situation. A crucial component of the problem is what and how to provide information to downstream customers as well as stipulate what and how information is received from upstream suppliers. In the longer run, managerial choice of the information set and the means for communicating it constitute a quality signal by the firm. Alternative signaling mechanisms abound.

This manuscript identifies and assesses broad classes of alternative signaling strategies regarding quality of the firm or its products and services.<sup>1</sup> The choice among strategies based on these alternative signals, or combination of alternatives, has both short- and long-run implications for the reputation of the firm, its products or services, the efficiency with which it conducts its business, and its competitive position relative to rivals. There are societal implications as well from societal endeavors to signal appropriate private firm conduct. Potential interaction among signals based on third-party guarantee strategies and private firm initiatives, such as differentiation through reputation building and branding, are examined. The broad alternative signaling strategy choices are evaluated relative to one another with some implications provided for managers and policy makers.

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<sup>1</sup> Quality is used here in the broadest sense. The authors intend for “quality” to include the usual sensory and price influencing attributes associated with U.S. Department of Agriculture federal commodity grades. Quality as used here also includes intangible societal attributes, such as “organic” or “natural,” based on production protocols, or firm reputation (i.e. quality of the firm) and, where appropriate, brand reputation (i.e. quality of a product).

## **Aspects of Firm Strategic Decisions Regarding Quality Signaling**

The dynamics surrounding genetic engineering capabilities for both grain and livestock along with food safety and animal welfare concerns combine to increase the need for information, communicated vertically within the supply chain. The information requirements to satisfy the need may not be customarily disseminated or even collected in the current supply chain. For example, dissemination of information regarding the slaughter conditions for meat animals or whether corn seed was genetically modified is typically not collected or disseminated within the conventional supply chain.

One response to this additional demand for the vertical flow of information has been what is commonly called identity preservation for grain and traceback for livestock. Each means the ability to know specific information on quality or other characteristics of a transacted commodity or product among upstream and downstream stages.

Efforts in the EU principally have centered on meat traceback along with two other aspects of vertical information flow, referred to as transparency and assurance (Liddell and Bailey, 2001). Transparency involves a principle stipulating that policies and regulations affecting transactions at one point in the supply chain should be clearly communicated to and across all other levels within the supply chain. For example, policies and regulations about sanitary and phytosanitary protocols at one stage in the supply chain should be easily understood and fully available to all other stages in the supply chain (Hooker and Roe, 2001). Assurance involves information on either or both food safety and quality factors of the commodity or products from the commodity. Food safety assurance, in meat animals for example, could involve information on pathogens. Information on quality could involve palatability, or

husbandry practices such as organic protocols (Augsburg, 1990, Unnevehr, et al., 1999, Wismans, 1999).

The strategy chosen can have long-term consequences on the firm's cooperative relationships with upstream suppliers and downstream customers, as well as competitive relationships with rival firms.<sup>2</sup> The authors presume all firms are operating in supply chains that exhibit structural embeddedness (Baum and Dutton, 1996, Darcin, et al., 1999). This simply recognizes that interfirm vertical linkages are based on cooperation but can influence competitive relationships across various vertical networks. Structural embeddedness limits the choice set of managers because firms are embedded in a myriad of ex ante relationships with other firms within a vertical network. This consequently influences competitive behavior of the firm but also its rivals (Gnyawali and Madhavan, 2001). Without structural embeddedness firm managers would have a less constrained set of alternative strategies available to them. In this case, available strategies would be constrained only by their own resources.<sup>3</sup>

Strategy choice influences risk mitigation through either sharing or avoiding risk. Risks regarding food safety are apparent. Some strategies may signal and concomitantly financially indemnify the firm in the event of liability to the customer, such as insurance or bonding. Other strategies, such as differentiation through branding and reputation-building, may not financially indemnify the firm in the event of liability and thus may not directly mitigate financial risk

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<sup>2</sup> Signaling that involves vertical information flows in a supply chain is interdependent with the intellectual capital of firms within the supply chain. Vertical information flow within a supply chain is likely to depend on firms' intellectual capital. The managers' task is made more complex because alternative signaling mechanisms involve vertical signaling of quality and also implicitly include interaction with the management of intellectual capital. Intellectual capital consists of three components: human capital, social capital, and structural capital (Seemann, et al., 2000). Human capital is a composite of all the skills, knowledge, and experience possessed by those employed by the firm. Social capital refers to the composite of contacts, trust, and collaboration efficiency that exists within the organization (Nahapiet and Ghoshal, 1998). Structural capital refers to the usual physical assets of the firm along with intangible assets.

exposure for the firm. Yet other signaling strategies, such as information provided by third-party agents regarding quality, may serve to jointly implicate multiple firms within a supply chain so that liability risk is shared among vertically allied agents.

Finally, another aspect of signaling strategy may be for the purpose of creating value within a supply chain. A first mover firm may serve as a catalyst to encourage a vertical network to engage in activities that create value, based at least partially around identity preservation or traceback technology. The strategy may be used for dual purposes of signaling quality and creating value through developing a specialized end use market, such as for organic products.

### **Slack Created by Signaling Problems**

The nature of the signaling problem is examined in this section so that alternative strategies can be evaluated on a relative basis. Three key elements of the signaling problem include: information asymmetry, incentives asymmetry, and measurability. The foundation for each of these is examined.

With the cascade of events regarding genetic engineering, food safety, and animal welfare, firms must signal their assiduity to downstream firms concerning the intangible societal attributes of their food and fiber products. Simultaneously consumers and society must signal to firms the appropriate precautionary behavior they should engage in when marketing novel products based on innovation and novel technologies. The signaling problem is bi-directional.

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<sup>3</sup> Stated another way, without the recognition of vertical linkages and structural embeddedness, two identically endowed firms would have the same choice set, and the choice among the set is constrained only by firm resources.

## *Information Asymmetry*

Akerlof (1970) was the first to model how inadequate signaling due to information asymmetry between buyer and seller caused a market failure. In his example, the market for used cars failed because in equilibrium the average quality of used cars was low even though there was potentially an ample supply of high quality cars that could enter the market.<sup>4</sup> What Akerlof revealed in his seminal research was the role information played affecting firms' business behavior. While the specific setting of the "lemons" problem is a marketing case, the power of this type of asymmetric information permeates business strategy and the business' capital plan. That is, if a firm cannot receive a proper return on investment pertinent to a certain failed market, capital will be diverted, in effect biasing the investment. While on the one hand this is efficient in directing resources to their highest return; but with respect to social product attributes there may be societal externalities. In the Akerlof setting, loss accrues only to consumers who have sub-optimal selection and sellers who go under compensated. When social attributes are added to the exchange bundle, significant societal externalities now can be created by the market failure.

As more and more agricultural research is conducted privately, where and how private firms invest affects the novel products of tomorrow. Effective signaling strategies within the supply chain are needed so that investments, made ex-ante, correspond to the correct bundle of goods and attributes on offer ex-post. If, due to information asymmetry, inferior products are oversupplied or needed high quality products are undersupplied, the effected agents become a

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With structural embeddedness, these identically endowed firms may face different choice sets.

<sup>4</sup> Initially low quality cars (lemons) would enter the market along with high quality cars and the average quality would lie between the two. But because only the sellers knew the true quality, high quality suppliers would be unable to signal that their cars were in fact worth a premium. High quality cars would then not enter the market and the average quality would fall, a self-fulfilling prophesy for the consumer. Thus, the asymmetry of information

broader group. Efficient and precise signaling by the firm is then critical because the stakeholders are more extensive.

### *Incentive Asymmetry*

A product's long-term value is some combination of sensory and other price-influencing attributes in addition to a set of intangible societal attributes, for example, animal welfare. These societal attributes may not influence price, especially in the short-run.

This serves as the foundation for slack arising from inadequate signaling due to incentive asymmetry. In this case, the signaling problem is not between buyer and seller but between the firm or supply chain and society. The marginal effects to the supply chain or firm are asymmetric to those of society. Society is challenged to adequately signal firms regarding societal expectations so that private firm behavior can be modified in a manner that considers the longer-term consequences and wider implications of the product.

The classic example of this is the tragedy of the commons. In this case the full impact or cost of an agent's private actions are not fully internalized. This occurs because the property rights arising from the productive activity are either not fully defined or assigned. In the classic case of natural resource extraction (Coase, 1960), the firm extracts at a rate above a socially optimal level. As in the "lemons" case, inadequate signaling leads to an inferior market outcome.

### *Arduous Measurability*

Finally, inadequate signaling can occur out of innocence due to difficulty in measurement. The measurement enigma results in inadequate signaling because critical information is unavailable and uncertainty abounds. It is not just that information is asymmetric

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between a seller and a buyer creates a market where it is assumed that all quality is inferior, high quality products are undersupplied, and inferior products define the market.

across the transaction interface. Information or useful metrics may be non-existent at the time of the transaction. A key component of efficient markets is the ability to signal accurately (Riley, 2001). Inferior results can occur because of uncertain metrics.

One solution to the above tragedy of the commons problem would be to assign property rights in a way that internalizes the externalities (Coase, 1960). This involves the ability to measure the offense and purposefully design disincentives. What if neither the firm nor society can measure the offense? What if the offense is unknown in the present time and is only revealed generations afterwards? Similar measurability problems are examined in the environmental management literature (Costanza and Perrings, 1990; Thomas and Randall, 2000; Goldsmith and Basak, 2001) and are pertinent to the food supply chain challenge of attempting to navigate consumer and societal expectations vis-à-vis intangible societal attributes.

### *Supply Chain Challenges*

The contemporary challenge for food supply chain involves all three dimensions of signaling. The “lemons” problem of information asymmetry occurs when marketers of, say a non-genetically engineered product, are unable to differentiate their product due to customer confusion over phrases such as “non-genetically engineered” or corollary terms such as “organic.” These generic terms become ineffective signals over time because only the seller knows the true state of the product.<sup>5</sup> The “open marketplace” allows entry of many product types, with the consequence that inferior quality product free rides on the initial good will engendered by high quality product. Long-term, high quality products are unable to exact a sufficient premium and consequently exit the market, with survival of only the lower quality products. An illustration of signaling asymmetry is consumers’ attempts at distinguishing among

and understanding “non-genetically engineered,” “organic,” and “natural” food labels (Sheldon, 2001).

The potential for inadequate signaling related to the “commons” problem can arise from regulatory gaps that occur. Such gaps are exacerbated when both technology and consumer expectations are evolving rapidly. For example, consider the maintenance of non-genetically engineered corn germplasm. Society may have a preference to keep a sustainable level of a “stock” of non-altered genetic material. Maintenance of such stock though is challenged by pollen drift. The recent StarLink™ corn incident rejuvenated pollen drift as an issue. The governmental regulatory framework was not in place to manage the stock of non-genetically engineered corn germplasm. Rapid technological advance combined with the pernicious problem of pollen drift resulted in a regulatory system unable to signal society’s desired behavior to firms so that externalities could become internalized. A predicament has arisen whereby the stock of non-genetically engineered germplasm is threatened by the private action of individual firms marketing approved genetically engineered events. Private decisions among seed suppliers results in threatened “purity” of certain genetic lines.<sup>6</sup> Effective signaling under conditions of rapid change is difficult. The firm is challenged to signal that it has been sufficiently diligent and society is challenged to signal the appropriate amount of pre-testing and caution.

Arduous measurability is one aspect of signaling particularly challenging to the food supply chain. How do consumers signal to food firms the correct amount of precaution they expect when the firm is dealing in novel technologies, such as products from genetic engineering? What metrics should firms employ to signal back that they have done so? The

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<sup>5</sup> In this context, the sellers may know much about the product and the processes employed to produce it but still may not have information useful for judging the importance of longer-term societal concerns, such as the probabilities of various unintended consequences of product or process technology.

importance or value of these intangible societal attributes are subjective, culturally dependent, and dynamic. Society's understanding and preferences may be as immature as the products being marketed. Many of the concerns relate to indirect impacts, unintended impacts, or lagged impacts with uncertain metrics.

### **Alternative Quality Signaling Strategies**

Broad classes of signaling strategy alternatives are identified here. Each broad class contains a subset of more specific mechanisms. The alternative quality signaling strategies include (in no particular order):

- Strategies which rely on signals from third-party (private or government) protocols and procedures
- Differentiation through branding and reputation
- Indemnity strategies: insurance, warranties, and bonding
- Vertical coordination strategies such as strategic alliances and vertical integration or internalization

These strategy alternatives are evaluated relative to one another and some implications are provided in the summary.

#### *Signals Relying on Third-Parties*

One possible strategy for the firm is to rely on third-party provision of signaling mechanisms. The strategy consists of signals that rely on third-party procedures, such as government or third-party private firm provision of standards, quality control, and/or signaling services. For some agricultural commodities this could be continued reliance on government

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<sup>6</sup> This situation is analogous to over-fishing, where the aggregate of multiple private decisions menaces sustainable

regulations to serve as the trust broker. For example in the U.S., grades such as “USDA Choice” and “#2 yellow corn” have served for many years as the information currency and imparted much of what buyers and sellers needed or demanded to know. However, “USDA Choice” signals little or nothing about animal welfare. The grade “#2 yellow” signals nothing about the genetic material of the corn. These grades/standards are not designed to address the new information demands that some customers place on the food system. The situation arises, at least partially, because commodity grades are intended for quality signaling in commodity transactions, not necessarily as optimal signaling to food supply chain customers with dynamic and highly specific needs.

With respect to this question of effective signaling, two factors challenge the government provision of signaling protocols. These challenges are the speed of the change and the uncertain metrics of the problem. Technological change affects not only the products being marketed but also the processes of production. Whether they are federal grades for the hole size in Swiss cheese or the quality of meat, agricultural commodity standards historically have been definitive and relatively static. The U.S. government regulatory system appears to have adequately addressed the “lemons” problem, minimizing inferior product problems through grading and its enforcement system. However, as product processes have become more specialized, advanced technologies more pervasive, and product attributes more unique, food supply chain and societal dependence on the government’s broad standards becomes less effective. Transactions involving value added food products give rise to unique bi-directional informational demands, making commodity-based signaling inadequate in relation to the entire food supply chain.

Compounding the signaling problem is the rate of these changes. A government bureaucracy’s efficiency is its ability to establish industry minimums and to routinize large-scale

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levels of certain fish stocks.

tasks, such as applying grades and standards to commodities. When the number of product attributes dramatically rises, government is hard pressed to keep pace with relevant metrics. The rise of intangible societal attributes consequently creates economic value associated with differentiation of even the most basic agricultural commodities. Differentiation, done by private firms, evolves as a signal about quality that enhances or replaces the signals provided through third-party governmental means.

When government signaling is inadequate, uncertainty abounds and the markets fail to perform efficiently, unless the private provision of signals evolves. With just governmental signals, some firms free ride resulting in oversupplying the market with inferior products that the broad or out-dated government standards are unable to filter out. Other firms are unable to capture premiums commensurate with their product's quality. The result is the average quality of the products in the domain of the government grading system falls. Additionally, dynamics lessen the utility of particular government grading systems when innovation and demand along the supply chain changes rapidly. Such information failures can result in societal risk, i.e. StarLink™ or inadequate product definition such as “organic.”

#### *Differentiation Through Branding and Reputation*

Another strategy for the firm consists of signaling mechanisms based on differentiation through brands for the product or reputation for the firm. Reputation is some forecast of consistency over time given knowledge of the aggregate of past events. Firms that trade commodities may not have brands on the items they sell but they still may have a substantial stake in their reputation. In fact, reputation is a form of market signaling. Reputations are built on credibility and the more credible the source the more influence the signal has on the receptor (Herbig and Milewicz, 1997). A similar argument can be made for brands: positive brand

reputations (credibility) are associated by the customer with a consistent mix of quality and value over time. Thus, branding is a signaling process for numerous types of information, including consistency and quality (Al-Najjar, 1995).

In its simplest form, branding is both product differentiation and firm reputation. So-called umbrella branding, a common practice among multi-product firms, is the use of the same brand for several diverse product categories (e.g. toothpaste and baking soda). Branding and umbrella branding provide considerable information where experience goods are concerned, because customers are unable ex-ante to observe, test, or measure adequately any differences among competitive products.

Brands have special utility for signaling intangible societal attributes, such as animal welfare and non-genetically engineered products. Here the customer, ex-post, has difficulty in assessing quality based on consumption and whether the product complied with its stated claim. Consumption of a steak identifies its sensory quality to the consumer. Branding the steak as “Certified Angus” signals to the consumer, ex-ante, that the steak is consistent quality from similar genetics and a price premium is justified. Branding does not mean that the differences are well defined; only that differences exist. This differentiation signaling can be accomplished in a variety of ways; through, advertising (Milgrom and Roberts, 1986; Nelson, 1974; Nichols, 1998), reputation-building strategies (Shapiro, 1983), warranties (Gal-Or, 1989), or simply brand-building through capital investment (Klein and Leffler, 1981, Thomas, 1995).

Branding creates a private good. Government grading systems generate a public good. Through branding the firm communicates directly with the consumer. Trust is built because the firm makes investments ex-ante and requires repeat or multiple purchases over which to spread the investment. If the initial consumption experience fails to deliver, repeat purchases won't be

forthcoming and ill will may constrain sales. So for the firm, branding is incentive compatible as the risks are high whether they are from the loss of brand capital, warranty expenditures, reputation, or advertising expenses. A separating equilibrium emerges, high quality products are able to make it to the marketplace and premiums are captured.

Clearly branding mitigates the “lemons” problem. There is an implicit contract between the firm and the consumer in which the firm has no incentive to signal inaccurately. The consumer experiences what is expected or at least trusts the firm that the product contains the advertised attributes. For example, a consumer cannot use sensory criteria for an egg from a laying hen to incorporate or signal information about the pen space conditions of the hen—say 75 square inches of space or 62 square inches (minimum industry standard). However, customers trust suppliers to verify societal concerns even if there is no direct information available to the customer.<sup>7</sup> In this case the brand allows a separation in the marketplace by quality in the form of intangible societal attributes.

In terms of the arduous measurability problem, branding is quite mitigating as well. Customers may not be able to measure the quality of a product, say the environmental impact of the *Bacillus thuringiensis* (Bt) event in corn. But when Monsanto makes an assertion and a commitment to market the product there is an implicit contract with the farmer and many ultimate customers that due diligence and prudent safety measures have been employed.<sup>8</sup> Branding, as with *Bacillus thuringiensis* (Bt), is an effective signaling mechanism for private

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<sup>7</sup> This argument is similar to one by other agricultural economists that there are non-use benefits of information to consumers. That is, for benefits to accrue from enhanced information consumers may not have to use the information in a manner that alter their purchase decision. Padberg, in particular, has argued long and consistently that consumer information may have broad benefits for society and the entire supply chain, not just customer purchase decisions. For one of many possible examples see Padberg (Padberg, 1976).

<sup>8</sup> The distinction between explicit and implicit contracts is as follows: explicit contracts are formal and enforced through third-party sanctions (such as the courts) while implicit contracts are informal and rely on the reputation of the contracting parties for enforcement. There is interaction between contracts and reputation; some analysts suggest that explicit contracts are more uniform because of firm reputation (Al-Najjar, 1995).

exchanges between the firm and customer; and in a Smithian way, is beneficial to society as a whole.

Branding is less efficient though when uncertain and diffuse externalities are part of the situation. As mentioned, branding is an effective signal for the private exchange of goods, but what if the aggregate risks to society are greater than the risks born by the individual customer? It is not simply that the Smithian outcome is not efficient when private and societal preferences are heterogeneous. Traceability systems and process branding can address a portion of the market failure by discounting terminal products containing *Bacillus thuringiensis* (Bt) corn. The real failure of the branding system though is effectively insuring against large and unforeseen damages.

#### *Indemnity Strategies: Insurance, Warranties, and Bonding*

Might a declaration of insurance, much like a consumer product warranty, signal due diligence and quality? Insurance signals that if some negative event occurs customers are financially indemnified. Insurance may also imply a “warranty-like” signal that a negative event likely would result only from uncontrollable circumstances, rather than negligence on the part of the firm.

Insurance markets are viable when events are stochastic, and the distribution is known. The knowledge of the stochastic properties initiates the actuarial process and premiums reflect the overall risk. Thus ex-ante declarations of insurance coverage would address, in part, the tragedy of the commons problem. Like a tax, the act of maintaining an active and substantial policy would help internalize some potential costs of public spillovers.

What about the immeasurable risks, such as public unintended consequences? These might arise from novel technologies, employed but not fully understood, or from potentially

high-impact activities. Third party intermediation is one means that firms and governments can address the measurability problem, especially when the stakes are high. There are two general types of third-party intermediation. First there is vertical intermediation such as selling through a retailer. The retailer is assumed to have free will to take possession and then resell the product, risking its reputation. The retailer serves as the consumer's buying agent. This "double branding" strategy of using an honest broker, has been suggested as a more successful strategy signaling quality than unilateral certification by means of the manufacturer's brand alone (Garella and Peitz, 2000).

A second form of intermediation is arms-length involving third-party verification. Effective signaling could occur through objective and credible firms or governmental agencies. In the context of bi-directional signaling, the government's mandated use of third-party verification could signal to firms the degree of caution preferred by society. Examples of this would be private testing laboratories and services, HAACP (food safety), ISO 9000 (quality) series, and ISO 14000 (environmental) series.

An alternative mechanism that addresses the incompatibility between private and public risk bearing is the requirement of assurance bonds (Costanza and Perrings, 1990, pp. 58-59 and 64-65):

"Bonds are designed to confront the resource users with the marginal social costs of the 'worst case' (author's quotations) results of their activities undertaken... Where the time-distance between the parties at either end of an external effect is considerable, and where there is a high level of uncertainty about the nature or severity of the effect, and the scope for creating a market for that effect is limited."

A key incentive feature, different from the threat of litigation and large fines, is that bonding is an ex-ante process. Consequently internalization and caution are introduced into the

firm's managerial processes and investment strategies as the business model is being designed. Thomas and Randall focus on risks concerning the natural environment, suggesting assurance bonding to address a different sort of incentive problem (Thomas and Randall, 2000). Their concern is the potentially faulty decision-making and standard setting practices by risk neutral government agencies and their representatives. Government bureaucracies have limited liability and their agents bear little of the direct risk of their actions, which might result in overzealous or biased decision making<sup>9</sup>.

In application, a bond is a declaration of ex-ante liability rather than the current practice of the burden placed on harmed parties to raise claims ex-post (Costanza and Perrings, 1990, Thomas and Randall, 2000). The bond would be held to compensate those affected by the (ex-ante) immeasurable harm or until the uncertainty or risk had been reduced to commercially viable levels. To engage in the uncertain activity the firm would be required to post a bond in an amount equal to the "worst case scenario" losses. If such losses did not materialize or uncertainty was reduced over time the amount of the bond would decline. The burden is on the firm to provide evidence that the expectation of harm has declined and that their capital should be returned.<sup>10</sup>

#### *Vertical Coordination Strategies: Strategic Alliances and Vertical Integration*

The food supply chain is becoming more tightly coordinated through a number of different mechanisms and for a number of different reasons (Sporleder, 1994; Hobbs and Young, 2000,). Strategic alliances are defined as formal relationships vertically within the supply chain formed based on shared business objectives (Sporleder, et al., 1998). Strategic alliances include

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<sup>9</sup> Their example is the case of the government's release of non-indigenous species into the public waterways but could be extended to policies on the use of public rangelands or the controlled burning of national forests.

<sup>10</sup> A complete description of implementing the assurance bonding mechanism can be found in Constanza and Perrings and in Thomas and Randall.

joint ventures and often are between vertically linked firms to facilitate coordination and increase efficiency (Barney, 1997). Vertical integration refers to the single ownership and control of establishments across several stages within the supply chain.

In a broad sense, these strategies are about firms optimizing the trade-off among equity investment (often idiosyncratic), control, and flexibility. The dimensions of the quality signaling problem for firms is influenced fundamentally by this strategy. Across vertical stages in the supply chain where firms engage in strategic alliances or vertical integration, the information asymmetry dimension is mitigated with less influence on the incentive asymmetry dimensions of signaling. Indeed, part of the transaction cost efficiency inherent in coordination stems from “privatizing” the signals about quality and bringing most or all value-altering quality attributes under managerial discretion. Efficiency gains are expected partly because noise and uncertainty is reduced through bi-directional vertical communication of a more complete set of information.

Signal privatization and enhancing efficiency through richer and more complete private vertical information flows does not inherently mitigate incentive asymmetry. For competitive reasons, structural embeddedness does provide incentives to private firms to signal to society in appropriate ways. However, coordination through strategic alliances and vertical integration does little to assist society signaling to firms concerning societal expectations.

The arduous measurability problem may be mitigated to some degree through closer vertical coordination. Vertically allied firms communicate more closely and may be more innovative in designing metrics useful for the bi-directional information problem. Again, however, this is privatized and has little influence on the incentive asymmetry dimension.

Part of the incentive asymmetry challenge that managers face arises from the extendedness and complexity of the traditional agriculture commodity-food supply chain. Again

consider the Burger King example where it attempts to signal customers about the animal welfare attributes of its products. What verification system does Burger King put in place in order to know that a hen with 75 square inches of living space produced each egg? The expansive and multifarious supply chain from production through wholesaling impedes an efficient Burger King knowledge base, reduces its ability to credibly signal, and accordingly reduces consumers' trust in the longer-term. On the one hand, the firm is signaling to consumers and attempting to build trust. However, brand equity is at risk because their supply chain governance might break down, an outcome for Burger King management beyond their control. Such problems are potentially frequent because of the complex disaggregated nature of the supply chain.

Continuing with the Burger King example, the challenge is how to manage their supply chain in a manner that balances the cost of supply chain control with the need to deliver on their customer pledge. By full vertical integration or enhancing coordination, the firm is able to align all incentives internally within the firm and, *ceteris paribus*, information flows are optimized. Does the risk from a system breakdown warrant integrating upstream into production?

Alternatively, a contractual relationship could be struck between a specialized laying operation and Burger King. The challenge would be specifying the contract and enforcing performance. The contract must provide the proper incentives so that the supply firm invests properly and shares some of the risk. Co-branding between the supply firm and Burger King forces mutual reputation signaling and forces the supplier to bear some of the risk.

Finally, Burger King could rely on third-party verification of its suppliers. Important for credibility is that the verification process is transparent, dynamic, precise, and critical. If possible, a verification mechanism strategy that incorporates relationships with otherwise

antagonistic groups, such as PETA (People for the Ethical Treatment of Animals), may enhance credibility because the group serves as an “honest broker” from a customer standpoint.

### **Conclusions and Implications**

As never before, the cascade of events regarding genetic engineering, food safety, and animal welfare persuade firms to carefully craft a signaling strategy regarding quality. Even firms in the early stages of the supply chain that deal exclusively with commodities prudently will now consider signaling strategies relative to quality. Managers of private firms within the food supply chain must decide what and how to provide information to downstream customers as well as stipulate what and how information is received from upstream suppliers.

Alternative signaling mechanisms abound. The strategic decision crafted should specifically recognize demands for information on intangible societal attributes in addition to the usual food safety and quality attributes. Simultaneously consumers and society must be diligent at signaling firms concerning the appropriate precautionary behavior they should engage in when marketing novel products based on innovation and novel technologies. The signaling problem in the supply chain is bi-directional.

A traditional basis for rivalry among firms has been the efficiency of tangible assets, such as plant and equipment, where efficiency and low cost are of paramount importance. This is the foundation of a commodity-based system. The need for identity preservation or traceback techniques, encourage alternative strategic patterns to emerge. Structural embeddedness dictates that managers consider alternative strategies for rivalry based around tighter vertical information flows, quality monitoring and signaling throughout the supply chain, and differentiation of the firm or its products.

The choice among these alternative signals, or combination of alternatives, has both short- and long-run implications for the reputation of the firm, its products or services, and the efficiency with which it conducts its business. The signaling problem in the supply chain has three important dimensions: information asymmetry, incentive asymmetry, and arduous measurability. The dimensions serve as important indicators of potential performance among various strategies.

The broad choice set of strategies for signaling quality includes: strategies that rely on third-party protocols and procedures; differentiation through branding and reputation; indemnification strategies such as insurance, warranties, and bonding; and coordination strategies such as strategic alliances and vertical integration (internalization). Each mechanism for signaling is likely to provide different long-term outcomes relative to the three performance dimensions. No globally optimal strategy solution exists for the supply chain and/or society in general. Differentiation through branding and reputation is relatively robust in the performance dimensions. Among the broad classes of strategies, the differentiation strategy mitigates many signaling problems relatively well.

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