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AND PROCESSED FOOD EXPORTS:  
ISSUES OF FIRM-LEVEL ANALYSIS**

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EXPORTS: ISSUES OF FIRM-LEVEL ANALYSIS**

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# International Food Safety Standards and Processed Food Exports: Issues of Firm-Level Analysis

Donald MacLaren\*

## 1. Introduction

International trade in processed food products has grown substantially in recent years. Concurrent with, but not unrelated to, this growth has been increasing concerns by food consumers about the safety (and, quality, more generally) of the food that they eat. This increase in consumers' concerns about the health risks from food has stemmed in large part from well-publicised food scares such as BSE, from outbreaks of food poisoning caused by *E. Coli*, *Listeria* and *Salmonella*, from suspicions about the presence of pesticide and veterinary residues, and from newly-identified potential dangers such as acrylamide. As the supply chain has lengthened, new sources of risk have been introduced into it. The challenge for economic policy is to design production and international distribution systems which will give consumers the benefits of consuming a wide variety of high-quality food but doing so in a least-cost way.<sup>1</sup>

The objective in this paper is to review some of the issues about food safety at the level of the individual exporting firm and, in particular, how government can correct the market failure caused by the credence characteristic of food safety.<sup>2</sup> In what follows, no distinction is made between firms that produce processed food products for export and the firms that undertake the exporting. They are assumed to be vertically integrated. An economic framework which draws heavily on work by Segerson (1999) is presented next (Section 2). The information that would be required to implement a safe-food system is compared with the information that is being collected in the Indian and Thai surveys of firms engaged in producing and exporting processed food products (Section 3). Some conclusions follow (Section 4).

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<sup>1</sup> There is a substantial literature now available on the many economic aspects of food safety. For example, see Bureau *et al.* (2002), Buzby (2003), Caswell (1991), Krissoff *et al.* (2002) and OECD (1999).

<sup>2</sup> Goods are conventionally put into one of three categories: search goods (the characteristics are known prior to consumption); experience goods (the characteristics are known at the point of consumption); and credence goods (the characteristics are not known even after consumption, although they may become known after some time, e.g., food poisoning caused by eating contaminated food).

## 2. Economic Issues

Normally, it is argued that free markets will achieve the provision of the socially optimal quantity of a good. However, many of the elements which comprise high quality in foods, e.g., safety, the technology used in production of the food, the environmental sustainability of production systems, and absence of genetically modified organisms (GMOs), are largely unknown to the consumer in the absence of some signalling device. Safety of the particular food may or may not be known even to the producer of it. The imperfect information about the safety characteristic of food leads to a serious market failure, i.e., the socially optimal amount of safe food is not transacted. For example, pesticide and veterinary residues and the presence of GM ingredients cannot be known to the consumer at the point of consumption or even afterwards in the absence of the information provided by regulatory control or by certification and labelling. As a consequence, uncertainty in consumers' minds leads to a reduction in the demand for the product which in turn reduces consumers' welfare, as well as reducing the profitability of producers. Hence, society will not consume or produce the socially optimal amount of safe food in the presence of this market failure.

Consumers' uncertainty about the safety of the food product and its relationship with the position of the demand function raises a fundamental question. What happens when consumers' perceptions of the risk are different from those of the experts? Should public policy be based upon erroneous perceptions, presumably those of consumers, or should they be based on the presumably more accurate perceptions of experts? This is an issue discussed by Pollak (1998) but to which he gives no definitive answer. In the remainder of the paper, it is assumed implicitly that consumers' perceptions are closely aligned with those of experts and that alarmist over-reaction to scares does not arise.<sup>3</sup>

In economic theory, there are at least three recognised ways of overcoming the type of market failure inherent in asymmetric information. These are: the direct regulation of firms, in terms of setting a standard either on the production process or on the resulting product; the imposition of legal liability on firms (to consumers and to the state) for the damage caused to human health and well-being; and the provision of information to consumers (e.g., certification and labelling). Each alternative has its strengths and weaknesses depending upon the particular circumstances in the market. In the context of internationally traded goods, it is not obvious which way is most

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<sup>3</sup> On such alarmist over-reaction to the BSE scare in the U.K., see Viscusi (1996) for an analysis.

appropriate. For example, if both the importing and the exporting governments choose to regulate, they may do so in different ways and to different standards. The outcome is that governments, in trying to avoid conflict, may choose to harmonise their standards, or they may choose mutually to recognise each other's standards (equivalence of standards); or they each may use an international standard, e.g., as set by the Codex Alimentarius Commission. Legal liability is harder to implement when the good is produced in one jurisdiction and consumed in another, e.g., if the government of the importing country attempts to impose liability on firms in the exporting country. As an alternative, the government might hold the importing firms liable and leave them to determine the best means of action against their export suppliers. Labelling is often advanced as a way of providing information, e.g., country of origin labelling or a label containing a statement about the content of the food. However, if labels are to convey accurate information and are to be trusted by consumers, then governments in the exporting and importing countries need to provide assurances.

It is now generally accepted that the WTO Agreement on the Application of Sanitary and Phytosanitary Barriers (the SPS Agreement) has been beneficial overall to the international trading community in preventing SPS barriers from being used for protectionism (i.e., protecting domestic producers from import competition) rather than protection of consumers of imported food. In the Agreement, governments are encouraged to use the international standards for food safety which have been developed by the Codex Alimentarius Commission. However, adhering to these standards has also brought costs to the developing countries which export food products to the developed countries. These countries, and the producers and exporters within them, may find it technically and economically difficult to achieve the food safety standards required which, in some instances, are more stringent than the international standard.<sup>4</sup>

Increasingly, these standards are often being achieved through production processes rather than being imposed on the product itself because the costs of monitoring the production process are less than those associated with monitoring the product. However, the setting of standards on processes may involve the introduction of HACCP systems which raise the fixed costs of the firm.<sup>5</sup> For small-scale firms, these additional costs may raise the average costs of production to such an extent that they are forced to

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<sup>4</sup> For an discussion of the problems faced, see Athukorala and Jayasuriya (2003), Otsuki *et al.* (2001), and Unnevehr (2000 and 2002).

<sup>5</sup> For a discussion of the economic issues raised by HACCP, see Unnevehr and Jensen (1996).

go out of business. Hence, in the exporting country, the industry will become re-structured towards larger-scale firms.

Clearly, it is important for the government of an exporting country to correct the externality or spill-over that can be caused when firms cheat by not achieving the required minimum standard on process or product and do so in the expectation that they will not be discovered. Whether this form of market failure is an important one or not depends upon the number of firms that comprise the industry; the larger the number of firms, the higher would be the expectation that detection is unlikely. This form of market failure, if left unchecked, will cause a loss of exports as importing countries choose to import from other countries which are more reliable.

In the remainder of the paper, it is assumed that the government of the exporting country chooses to solve the problem of market information failure by evaluating whether the exporting firms should be subject either to mandatory regulation or to persuasion to form an industry association with self-regulation. The safety outcomes generated are assumed to be identical. Thus, the government is assumed to have ruled out using the alternatives of product labelling (although country-of-origin labelling is still possible) and legal liability on its exporters as the means of shifting the import demand function to the right. It is concerned only with identifying whether or not there is a sufficient incentive for an industry association to achieve the desired outcome of exports of safe food and to identify the information that would be required to achieve it.

### **3. A Model of Regulatory Measures**

It is necessary to show first of all that the unregulated export firms will not provide the socially optimal amount of safe food. The second step is then to evaluate the two alternatives of voluntary action by the association of exporting firms and mandatory regulation by the government.

Consider a small country that produces and exports a food product which has the credence characteristic, safety. The exporting firms in this country are perfectly competitive. There are no domestic consumers, an assumption which is made only to simplify the analysis and which will not change the results unless the importing and exporting country consumers have different preferences with respect to safety. In the importing country, there are consumers of this product but there is no domestic production, again for simplicity and to abstract from the protectionism or protection

debate. The exporting country competes with other exporting countries but not in a strategic way. This assumption is necessary to ensure that the price received is not influenced by the volume of exports. However, it will be assumed that the safety of the product exported may influence the price received.

This set of assumptions distinguishes the analysis to follow from other analyses in the literature dealing with trade and imperfect information. For example, Bond (1984), Bureau *et al.* (1998), Jansen and de Faria (2002), Lutz (2003), and Roe and Sheldon (2002), each used a utility function consistent with a vertically differentiated product. With the exception of Lutz, these authors analysed the effect of labelling on the gains from trade when there is an information failure. Lutz analysed the mutual recognition of standards. Perfectly competitive firms were assumed by Bond, Bureau *et al.* (1998) and by Jansen and de Faria. On the other hand, both Lutz, and Roe and Sheldon constructed non-cooperative games involving two firms and two countries in which product quality and price are set in two of the stages. In a closed economy, Segerson (1999) analysed a commodity market subject to imperfect information and assumed that legal liability was the means by which the market failure was solved, rather than labelling. In what follows, part of the analysis presented in Segerson is extended to a trade situation, the means of correction is retained, i.e., minimum standards arrived at voluntarily by an association of exporting firms or by mandatory government regulation. But her analysis of the use of a government subsidy to induce firms to form an association and the amount of information known by the firm about the safety of its product are not included. Instead, it is assumed in what follows that firms have perfect information about the safety characteristics of their product.

The variables to be used are as follows:

$B(Q)$  is the consumers' gross benefit from consuming an amount  $Q$ , where  $B'(Q) > 0$  and

$$B''(Q) < 0;$$

$s$  is the probability that a unit of the product is contaminated and will cause harm to consumers;

$D$  is the damage to the consumers' health from consuming a unit of contaminated food, i.e., it is the hazard;

$C(s, Q)$  is the exporting industry's total cost function, where  $Q$  is output,  $C_s < 0$ ,  $C_Q > 0$  and  $C_{sQ} < 0$ ;

$p(s)$  is the international price of the food product, noting that price is not a function of  $Q$  because of the small country assumption;

$\alpha$  is a scale factor which reflects the consumers' knowledge of the safety of the food, where  $0 \leq \alpha$ , with  $\alpha = 0$  meaning that the consumer has no knowledge of the risk,  $\alpha = 1$  meaning perfect knowledge and  $\alpha > 1$  meaning that there is exaggerated view of risk;

$L$  is the financial loss to the exporting industry from contamination attributed to it by the importing country.

Consumers are assumed to be risk neutral.

The import demand function is derived from maximising consumers' net benefits,  $CS$ , where

$$CS(s, Q) = B(Q) - p(s)Q - \alpha s D Q \quad (1)$$

The last term measures the consumers' knowledge of the expected harm cause by consuming contaminated food, i.e., the expected value of the hazard. It can be reduced, for given  $\alpha$  and  $D$ , by firms taking measures to reduce  $s$  or by consumers consuming less and reducing  $Q$ . Maximising equation (1) with respect to  $Q$  and re-arranging gives the import demand function

$$p(s) = B'(Q) - \alpha s D \quad (2)$$

Differentiating equation (2) with respect to  $s$  gives

$$p'(s) = -\alpha D < 0 \text{ for } 0 < \alpha .$$

This inequality shows that if consumers were prepared to pay more for safer food, then the import demand function would shift downwards in the face of imperfect information ( $\alpha \neq 1$ ). However, if  $\alpha = 0$ , i.e., if consumers are totally unaware of the risk of contamination, then there is no shift in the import demand function.

For the exporting industry, the amount of contamination and the amount of the product to export is determined by maximising profit, i.e.,

$$\max_{s, Q} \pi(s, Q) = p(s)Q - C(s, Q) \quad (3)$$

The first-order conditions are

$$p'q - C_s = 0 \quad (4)$$

$$p(s) - C_Q = 0 \quad (5)$$

The equilibrium level of the industry's output is obtained from substituting equation (2) into equation (5) to get

$$B'(Q) - C_Q - \alpha s D = 0 \quad (7)$$

The private optimal level of output is found where marginal gross benefit less the consumers' perception of the expected hazard equals the marginal cost of output.

The issue now is to determine whether this value of  $Q$  obtained from equation (7) is identical with the socially optimal level of output under perfect information. Let the joint welfare in both countries be

$$W = B(Q) - C(s, Q) - s D Q .$$

Maximising this function with respect to  $Q$  and to  $s$  yields the socially optimal levels of consumption and safety. The first-order conditions, respectively, are

$$B'(Q) - C_Q - s D = 0 \quad (8)$$

$$-C_s - D Q = 0 \quad (9)$$

If the privately optimal outcome (equation (7)) and the socially optimal outcome (equation (8)) are to be identical, then for a given  $s$ , they will be equal if and only if  $\alpha = 1$ . But this result implies that consumers must have perfect knowledge of the safety of the product if the two output levels are to be identical. But perfect knowledge is ruled out by the credence nature of safety. Therefore,  $\alpha$  cannot be unity and there is market failure.

The nature of the market failure depends upon the size of  $\alpha$ . Suppose that consumers are unaware of the risks ( $\alpha = 0$ ), then from equation (7) and noting that  $C_Q > 0$ ,  $B'(Q)$  is 'too small' and there is over-consumption relative to the socially optimal level of  $Q$ . On the other hand, if consumers over-react to the risk of contamination ( $\alpha > 1$ ), then from equation (7) there will be under-consumption relative to the socially optimal level.

It has been established that when consumers do not have perfect information about the safety of the food product that they eat, there is a market failure which needs to be corrected. Assume that the correction of this failure lies with the exporting country either through voluntary action by exporting firms or through mandatory regulations imposed by that government, both of which achieve the socially optimal level of food

contamination (safety),  $s^*$ , derived implicitly from equation (9).<sup>6</sup> In the absence of correction of the market failure, it can be assumed that the privately chosen level of contamination,  $s$ , exceeds the optimal level. From equation (9), the optimal level depends upon the total size of the hazard ( $DQ$ ) and the marginal cost of increasing the level of safety ( $C_s$ ).

The benefit to the exporting industry of forming a voluntary association comes from shifting the import demand curve outwards. This shift occurs because of the improvement in consumers' perception of the safety of the food even if the chances of becoming ill are unchanged. Since  $p'(s) < 0$ , by reducing  $s$ , the import demand curve (equation (2)) is shifted outwards. Then exporters benefit from a higher price ( $p(s_v) > p(s_0)$ ) and a higher volume ( $Q_v > Q_0$ ), where  $v$  represents voluntary action and 0 represents no action.

The costs to industry caused by achieving  $s_v < s_0$ , voluntarily, e.g., from introducing a HACCP system, will be higher than in the no intervention case, i.e.,  $C(s_v, Q) > C(s_0, Q)$ . These additional costs, which arise from reducing the probability of contamination, will be offset not just by the additional revenues but also by a reduction in the losses of revenue caused by rejection of contaminated exports. Let these losses be  $L$ .  $L$  could be the total value of forfeited exports or it could represent the reduction in net revenue from exports which is caused by the industry having to incur the additional costs of shipping to another import destination.

Consider three cases: i) no intervention which is subscribed by 0; a voluntary association of exporting firms, subscribed by  $v$ ; and mandatory regulation imposed by government, subscribed by  $m$ , in which the same level of contamination is achieved as in the case of voluntary association (i.e.,  $s_v = s_m$ ).<sup>7</sup> Suppose the exporting firms have an expectation that if they refuse to form a voluntary association, then government may enforce a safety standard through regulation. Let the probability of regulation ( $r$ ) be  $0 \leq r \leq 1$ .

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<sup>6</sup> Of course, it could be case that the government of the importing country imposes minimum standards on imports. But with the structure of this model, it is more interesting to consider the means used by the exporting country to correct the information failure given that this country is implicitly competing with other exporting countries.

<sup>7</sup> The subscripts on the function  $C$  could cause some confusion because they have been used above to indicate the partial derivative with respect to the variable appearing the subscript. The subscripts 0,  $m$  and  $v$  should not be interpreted in this way but to indicate a different cost function.

Assume that the industry's costs of production may be greater or less under a voluntary arrangement than under regulation, i.e.,  $C(s_v, Q) \geq C(s_m, Q)$ . Likewise, the benefits to be derived from decreasing  $s$  may or may not also be different. Segerson (p. 59) discusses reasons why the benefits from the voluntary scheme may exceed those from regulation. They include the possibility that consumers in the importing country react favourably to the public relations aspect of the assurances and that they might regard a regulation as signalling that the product has a higher risk than was originally perceived. Despite this argument, it could also be the case that consumers put greater faith in a government regulation than they do in a self-regulating and voluntary scheme. Therefore, it is not obvious which scheme would generate the higher benefits for a given  $s$ . The losses ( $L$ ) are assumed to be the same because the same standard of safety is to be achieved ( $s_v = s_m$ ).

Assume that firms are risk neutral. Then the expected profit for the export industry under each scenario is as follows:

$$\begin{aligned} E\{\pi_v\} &= s(p_v Q_v - C_v - L) + (1-s)(p_v Q_v - C_v) ; \\ &= p_v Q_v - C_v - sL \end{aligned} \quad (10)$$

$$\begin{aligned} E\{\pi_m\} &= s(p_m Q_m - C_m - L) + (1-s)(p_m Q_m - C_m) ; \\ &= p_m Q_m - C_m - sL \end{aligned} \quad (11)$$

$$\begin{aligned} E\{\pi_0\} &= s_0(p_0 Q_0 - C_0 - L) + (1-s_0)(p_0 Q_0 - C_0) ; \\ &= p_0 Q_0 - C_0 - s_0 L \end{aligned} \quad (12)$$

The next step is to identify the conditions under which voluntary action will be implemented. Such action will occur if the expected profits from voluntary association exceed the weighted average of the expected profits gained from government intervention and from no action on safety:

$$E\{\pi_v\} \geq rE\{\pi_m\} + (1-r)E\{\pi_0\} . \quad (13)$$

Consider two extremes: it is known by the industry that government will not regulate ( $r = 0$ ); or it is known that government is certain to regulate in the absence of voluntary action ( $r = 1$ ). In the first case, equation (13) becomes, from equations (10) and (12),

$$(p_v Q_v - p_0 Q_0) - (C_v - C_0) - (s - s_0)L \geq 0 .$$

The first and second terms in parentheses are positive, and the second term in the third term in parentheses is negative. For this inequality to hold and a voluntary association to

form, the benefits of the association in the form of additional revenues  $(p_v Q_v - p_0 Q_0)$  and a reduction in the expected loss from attributed contamination  $(s - s_0)L$ , must outweigh the costs of reducing  $s$  voluntarily,  $(C_v - C_0)$ . In the second case, equation (13) becomes, from equations (10) and (11),

$$(p_v Q_v - C_v) \geq (p_m Q_m - C_m).$$

This inequality will hold if the net revenues from the voluntary association are greater than those from regulation. A priori, it is not possible to reach a conclusion but there is perhaps a presumption that the firms' costs under regulation may be higher than those under a voluntary association and if the revenues are the same, then the inequality will hold and a voluntary association will form.

#### 4. Discussion

It may be inferred from the variables which appear in inequality (13) that the information required to determine whether the conditions exist for a voluntary association could be obtained on the basis of market and survey information. For each of the three cases, subscripted by  $v$ ,  $m$  and  $0$ , prices received ( $p$ ), export volumes ( $Q$ ), costs of production ( $C$ ), the value of sales lost because of contamination ( $L$ ), the probability of contamination ( $s$ ) and the likelihood of the imposition of mandatory regulations ( $r$ ), are either known from existing market conditions or they could be obtained, at least in principle, from the exporting firms surveyed.

#### 5. Conclusions

In recent years, the food supply chain has lengthened and, with that lengthening, additional sources of risk to the safety of food have emerged. Because safety is a credence characteristic, there is a market failure which is caused by asymmetric information. In this paper, a model which is based on the work of Segerson has been extended to a simple international trade situation. The analysis conducted has been restricted to that of the correction the market failure by the exporting country through either a voluntary association of exporting firms or the imposition of mandatory regulation by government. Previous work in this area, almost exclusively, has considered labelling as the means of correcting the market failure.

It was found from equation (13) that it would be possible to gather the necessary information through a combination of observed market outcomes and survey information

to make the model operational. The issue of safety in internationally-traded food products is of increasing importance to several developing countries, including India and Thailand. It is vital that the foreign exchange earnings derived from their exports of food products are not constrained by their ability to solve the market failure. It is also vital that the importing countries maintain safety standards which are consistent with those established by the Codex Alimentarius Commission, otherwise they impose an unnecessary burden on the exporting countries.

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