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Economic Incentives for Food Processors to Adopt Enhanced Food Safety Controls: Evidence from Canadian Red Meat and Poultry Processing Sector

J.M.U.K. Jayasinghe and S. Henson[1]

Department of Agribusiness Management
Faculty of Agriculture and Plantation Management
Wayamba University of Sri Lanka, Makandura
Gonawila (NWP), Sri Lanka

ABSTRACT. *This study assesses quantitatively the economic incentives for firms to adopt enhanced food safety controls, and the potential impact of a number of firm and market-specific characteristics on this behavior, focusing on the red meat and poultry-processing sector in Canada. The data from 251 firms (182 Federally-registered and 69 Provincially-licensed), which responded to a national survey consisting of 822 firms, were analyzed using Ordered Logistic regression techniques. To reflect each firm's propensity to implement food safety controls, five-ordered variables that were derived from the values obtained by an index (Food Safety Responsive Index) were included as dependent variables in the empirical model. The impacts of individual incentives (explanatory variables) were computed using Confirmatory Factor Analysis. The firm and market-specific characteristics were specified using a series of dummy variables. In contrast to the findings from the previous studies that over-emphasized the role of government regulations and the shortcomings of the market, this study suggests that market-based incentives such as perception of adopting enhanced food safety controls is a "good practice". Reputation, and procedural efficiency play a greater role than regulatory (existing and anticipated government regulations) and liability incentives. The relative effects of incentives, however, vary widely between the Federally-registered and Provincially-licensed firms. The results suggest that policy makers should move beyond traditional regulatory modes to implement a system that is sufficiently flexible to reflect differences in the incentive based individual firms, i.e. an incentive-based regulatory system.*

INTRODUCTION

Although the food supply in most developed countries is generally considered safe, modern industrial food systems cannot fully eradicate the potential disease-causing agents in food. The estimates suggest that the costs associated with foodborne diseases are substantial. Some 2.2 million cases of foodborne illnesses occur annually in Canada involving about 13 % of Canadians. This costs approximately C$4 billion to the economy every year (Veeman, 1999). The Economic Research Service (ERS) of the United States Department of Agriculture (USDA) estimates that the annual cost of food-borne illnesses and premature death in the United States is around U$1.1 to U$1.3 billion over 20 years (Crutchfield *et al.*,

[1] Associate Professor, Department of Agricultural Economics and Business, University of Guelph, Guelph, ON, N1G 2W1, Canada.

1997). In these countries, the red meat and poultry processing sectors are responsible for the majority of the incidences (Buzby *et al.*, 2001).

Although the costs are only partly imposed on food processing firms, in the presence of food safety risks, the firms may realize that the direct (*e.g.* liability law suits) and indirect (*e.g.* loss of reputation) costs of food safety failures are higher than the costs of mitigation (*i.e.* costs of implementing food safety controls). Further, potential consumer reactions to "real" or "perceived" food safety risks such as product avoidance and brand switching can provide incentives for food processors to undertake precautions to reduce food-borne hazards at processing (Henson and Caswell, 1999).

Buzby *et al.* (2001). suggest three elements that create incentives for food processing enterprises to adopt enhanced food safety controls: (1) market forces; (2) food safety laws and regulation; and (3) product liability laws. Much of the literature has, however, downplayed the role of market-based incentives, although more recently the environmental (Segerson, 1986; Segerson and Miceli, 1998) and food economics (Henson and Holt, 2000; Segerson, 1999) literature has begun to acknowledge the wider economic incentives that influence such firm-level behaviour. Public legislation provides regulatory incentives for firms to behave food safety in a responsible manner, where it may vary substantially both between countries and between States/Provinces within countries. There is no exception in the context of Canadian food safety regulatory system (Spriggs and Isaac, 2001). Firms that are "non-compliance" can be subject to various penalties imposed by the courts and/or government agencies such as Canadian Food Inspection Agency (CFIA) in terms of fines, product recalls and temporary or permanent closure. Product liability laws are characterized by criminal and/or civil sanctions with potential financial compensation for those affected and punitive damages for the responsible parties (Buzby *et al.*, 2001). Both of these approaches are used in developed countries to varying degrees to secure a safe food supply, although with statutory safety standards used most frequently as the principal approach (Antle, 1995).

There is an on-going debate involving economists and policy-makers regarding the most effective and desirable mechanisms to achieve an appropriate level of food safety. Much of this debate has tended to over-emphasize the role of government regulations and the shortcomings of the market ignoring the wider economic incentives for food processors to adopt food safety controls. A few studies have been undertaken to examine this problem using the data from the US and European counties (Carlson and Carlson, 1996; Henson and Holt, 2000). In Canada, few such research has been carried out to date on this issue, especially utilizing quantitative analysis. One exception is Mehta and Wilcock (1996) that examines the potential motives for firms in the Canadian food sector to implement a food safety and quality metasystem such as a Hazard Analysis and Critical Control Points (HACCP) and/or other quality system such as ISO 9000.

The outcomes of previous analyses suggest that the motivation for food businesses to implement both public and private food safety controls reflect the prior expectations of decision-makers in those firms regarding the potential benefits and costs associated with adoption. In cases where businesses perceive the "costs" of implementation to be high relative to the expected "benefits" and when the difficulties associated with adoption cannot be easily avoided, there may be less motivation for managers to implement enhanced food safety controls. In situations where both private and public approaches are interconnected and operate 'side-by-side', it is important to understand the individual incentives to implement food safety controls at the firm level, and the role of regulation on these incentives.

This study examines the role of alternative economic incentives for firms to behave food safety responsible manner by adopting enhanced food safety controls and the potential impact of firm and market-specific characteristics. It is, perhaps, the first comprehensive economic analysis carried out to solve this particular problem using the data from firms operating in the Canadian food processing sector.

METHODS

The research study has been designed to be completed in two stages. This paper presents the results of the second stage. In the first stage, a series of in-depth interviews (n = 36) with quality assurance managers in red meat and poultry processing firms in Ontario was conducted. These aimed to identify the incentives for firms to adopt enhanced food safety controls. Interviews were recorded and transcribed. The content of the interview scripts was then analyzed using the *N-Vivo* qualitative data analysis software, which classified these incentives into 10 major categories: (1) financial implications / cost (CT); (2) human resource efficiency (HE); (3) procedural efficiency (PE); (4) "good practice" (GP): (5) sales (SL); (6) reputation (RT); (7) commercial pressure (CP); (8) existing government regulation (ER); (9) anticipating government regulation (AR), and (10) liability laws (LL) (see, Jayasinghe-Mudalige and Henson, 2003 for details on the outcome of the first stage).

The second stage was designed to "quantify" the extent to which these 10 individual incentives influence food safety responsive behaviour of firms.

Analytical framework

Setting of an appropriate model for the purpose of analysis to reflect the food safety responsive behaviour of a firm that is triggered by various incentives it faced is complicated by a number of reasons, including: (1) the fact that Canadian food processing firms implement a range of food safety practices, for example HACCP, ISO 9000, Good Manufacturing Practices (GMP) etc. (Baldwin., 1999); (2) such actions are induced by a large number of individual incentives and which are prevailing as system at the firm level (Buzby *et al.*, 2001); (3) many of which are 'unobservable' at the firm level (Hair *et al.*, 1995), and (4) are highly subjective to individual managers (Buchanan, 1969). By taking into account of these factors, the outcome of a number of previous analyses, including Caswell *et al.* (1998) and Nakamura Takahashi and Vertinsky, (2001), and certain agency models of the firm (Jenson and Meckling, 1976; Williamson, 1986) were used to develop the following simple analytical framework:

$$D_i = f\,(I_i,\ F_i) + \varepsilon_i \qquad (1)$$

In equation (1), D_i represents the "level of food safety responsiveness of a firm". This was captured by means of an index – defined as "*Food Safety Responsiveness Index*" (FSRI) to be included as the dependent variable in the empirical model (Equation 2). This was computed by taking the mean of the scores given in response to a set of statements (n = 12) regarding the firm and food safety.

Confirmatory Factor Analysis (CFA) and the computation of multi-item summated scales (Henson and Traill, 2000) were used to develop estimable variables ("Scale Values") for the incentives of interest (I_i) for the empirical model. In turn, the individual incentives identified in stage-one were specified as "constructs" in the "measurement model" of CFA (Hair et al., 1995). Next, a set of attitudinal statements selected from the interview scripts from the stage-one to reflect the observable characteristics of each incentive were employed as "indicators" to represent these constructs (*i.e.* incentives), together with a set of "validation items" (Henson and Traill, 2000) for each construct. The set of dummy variables in the model were incorporated explicitly to reflect the firm and market-specific characteristics (F_i) (see, Table 1 for details on the variables):

$$D_i = \beta_0 + \beta_1 \cdot CT + \beta_2 \cdot HE + \beta_3 \cdot PE + \beta_4 \cdot GP + \beta_5 \cdot SL + \beta_6 \cdot RT + \beta_7 \cdot CP + \beta_8 \cdot ER + \beta_9 \cdot AR + \beta_{10} \cdot LL + \sigma_1 \cdot FR + \sigma_2 \cdot ON + \sigma_3 \cdot VS + \sigma_4 \cdot S + \sigma_5 \cdot M + \sigma_6 \cdot L + \sigma_2 \cdot VL + \sigma_3 \cdot SG + \sigma_4 \cdot CB + \sigma_5 \cdot MF + \sigma_6 \cdot ST + \sigma_7 \cdot BF + \sigma_8 \cdot PK + \sigma_9 \cdot LG + \sigma_{10} \cdot PL + \sigma_{11} \cdot OA + \sigma_{12} \cdot GC + \sigma_{13} \cdot FS + \sigma_{14} \cdot RS + \sigma_{15} \cdot RU + \sigma_{16} \cdot PC + \sigma_{17} \cdot WS + \sigma_{18} \cdot WI + \sigma_{19} \cdot PV + \sigma_{20} \cdot IP + \sigma_{21} \cdot IT + \varepsilon_i \quad (2)$$

Data collection and analysis

In the stage-two, a questionnaire-based survey was conducted with a national sample of *Federally-registered* (FR) and *Provincially-licensed* (PL) red meat and poultry processing plants in Canada (n = 822) to collect data[2].

Those statements used to derive the FSRI (n = 12) and Scale Values of incentives of a firm (5 indicators per construct x 10 constructs = 60) were included in the questionnaire together with several other questions to gather specific information with regard to firm and market-specific characteristics of the firm, including number of employees, sales volume and areas, product types etc[3]. Respondents were in turn asked to score each statement on a five-point Likert scale (Oppenheim, 1992) from "strongly agree" at one extreme to "strongly disagree" at the other. There were 279 questionnaires back representing a 34 percent response rate. Having checked each questionnaire for its completeness of data, only 251 questionnaires were selected for the statistical analysis.

[2] The Canadian Food Inspection Agency (CFIA) and the Ministry of Food and Agriculture in each Province, respectively, regulate the Federally-registered (FR) and Provincially-licensed (PL) firms in Canada (Spriggs and Isaac, 2001).

[3] A copy of the questionnaire can be obtained upon request from the authors.

Table 1. Definition for variables used in the empirical Model

Variable	Description	
D_i	Dependent variables	
β_0	Intercept term	
β_i	Estimates for incentives (β_1 - β_{10})	
σ_i	Estimates for firm- and market-specific characteristics (σ_1 - σ_{22})	
ε_i	Stochastic error term	
Dummy Variables for Firm- and Market-specific Characteristics (Fi)		
Type (based on level of meat inspection) and location of the firm (Province)		
FR	Federally-registered firms	FR = 1; otherwise = 0
ON	Ontario	ON = 1; otherwise = 0
Size of the firm (Based on number of employees)		
VS	Very small (0 – 10)	VS = 1; otherwise = 0
S	Small (11 – 25)	S = 1; otherwise = 0
M	Medium (26 – 100)	M = 1; otherwise = 0
L	Large (101 – 250)	L = 1; otherwise = 0
VL	Very large (> 250)	VL = 1; otherwise = 0
Activity of the firm		
SG	Slaughtering	SG = 1; otherwise = 0
CB	Cutting and boning	CB = 1; otherwise = 0
MF	Manufacturing of processed products	MF = 1; otherwise = 0
ST	Storage (certified by the CFIA)	ST = 1; otherwise = 0
Products of the firm		
BF	Beef	BF = 1; otherwise = 0
PK	Pork	PK= 1; otherwise = 0
LG	Lamb and goat	LG = 1; otherwise = 0
PL	Poultry	PL = 1; otherwise = 0
OA	Other animals	OA = 1; otherwise = 0
Customers of the firm		
GC	National grocery chains and supermarkets	GC = 1; otherwise = 0
FS	Food services chains	FS = 1; otherwise = 0
RS	Retail stores	RS = 1; otherwise = 0
RU	Local Restaurants	RU = 1; otherwise = 0
PC	Meat processors	PC = 1; otherwise = 0
WS	Wholesalers	WS = 1; otherwise = 0
WI	Walk-in customers	WI = 1; otherwise = 0
Sales area of the firm		
PV	Within the Province firm operates	PV = 1; otherwise = 0
IP	Inter-provincial sales	IP = 1; otherwise = 0
IT	Exporting the USA and other countries	IT = 1; otherwise = 0

Data analysis followed several steps. Before obtaining the FSRI and the Scale Values of incentives of a firm, the scores given by the respondents for the statements were subject to a number of scale purification techniques used in CFA, including: (1) scale reliability; (2) unidimensionality, and (3) construct validity. A number of statistical methods have been used to estimate the parameters of the model. This paper reports in particular the outcome that used Ordered Logistic Regression techniques (Borooah, 2002; Pampel, 2000) which uses Maximum Likelihood methods for estimation. Two separate models were specified to represent: (1) Federally-registered (FR) [n = 182], and (2) Provincially-licensed (PL) [n = 69] firms. Estimates of "logits" (logged odds) with their relative size and sign of its effect and the Marginal Probabilities derived for each incentive were used to interpret the potential impact of incentives on the firms food safety responsive behaviour in turn.

RESULTS

Derivation of ordered dependent variables

Figure 1 illustrates that the distribution of FSRI amongst the firms in the sample (n = 251) ranged from 2.5 (the lowest) to 4.83 (the highest), with a mean of 3.68 ± 0.52 (Figure 1).

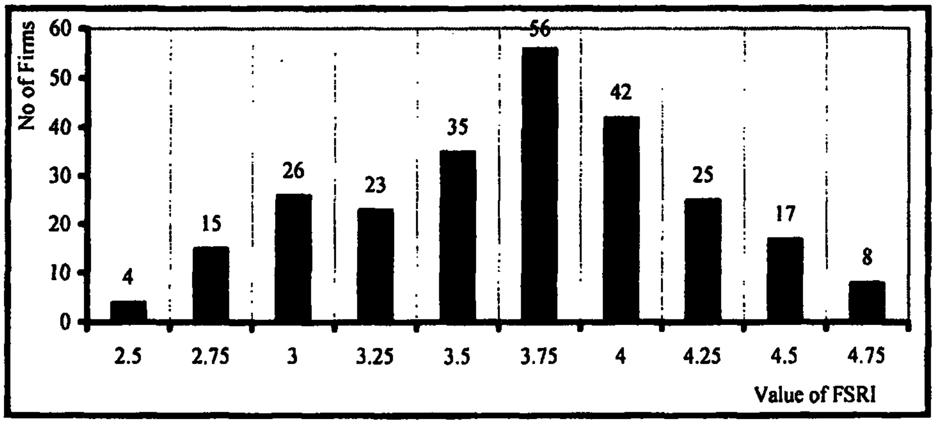

Fig. 1. Distribution of values of the food safety responsive index

Next, five ordered dependent variables (D_i = 1 to 5) were developed for Ordered Logistic Regression analysis using the "lower" and "upper" limits for the FSRI as indicated in the Table 2. These five categories exemplify all else being equal, it is more likely that a firm included in a higher category is more food safety responsive and adopts enhanced food safety controls than a firm included in a lower category.

Table 2. Ordered dependent variables

Variable Name	Degree of Responsiveness	Range of the Index		Number of Firms (n = 251)	Percentage (%)
		Lower Limit	*Upper Limit*		
D = 1	Very Low	2.50 *	2.92	27	10.8
D = 2	Low	3.00	3.42	51	20.3
D = 3	Medium	3.50	3.92	100	39.8
D = 4	High	4.00	4.42	59	23.5
D = 5	Very High	4.50	4.83 *	14	5.6

* Theoretically, the lower and upper limits should be 0.00 and 5.00, respectively. However, the minimum and the maximum value estimated for the index were 2.50 and 4.83.

Derivation of scale values of incentives using CFA

This section highlights the major results from the CFA used to derive the Scale Value of each incentive.

First, the Cronbach Alpha (Cronbach, 1951) of each statement was estimated to eliminate superfluous items, and to achieve the highest possible "scale reliability". A number of indicators included in each construct (incentive), as shown in Column (4) of Table 3, was selected, and others were excluded from the analysis based on the criteria commonly used in this respect (Henson and Traill, 2000).

Secondly, the unidimensionality of statements (remained in the model after the scale reliability testing) were calculated using Principal Axis Factoring. The results indicated that the scales were unidimensional; except for two statements the factor loadings were greater than 0.35. Amongst the 38 statements selected through the reliability analysis, factor loadings of 33 (87%) were more than 0.4.

Finally, the construct validity (Cronbach and Meehl, 1955) was measured with the single validation item included for each incentive applied as the alternative measurement instrument to develop a multi-trait multi method (MTMM) matrix (Campbell and Fiske, 1959). The results suggest that majority of coefficients correlated positively and greater than any other corresponding coefficient in the same column in the MTMM matrix. Thus, there was substantive evidence of construct validity of the variables included in the model.

Table 3. Procedures and the results of testing scale reliability

Incentive (1)	No of Items Considered (2)	Cronbach Alpha (3)	Items Remained (4)	Mean Score (5)	SD (6)
CT	5	0.733	5	15.23	3.89
HE	5	0.505	3	9.96	2.10
PE	5	0.496	3	10.92	2.01
GP	5	0.701	4	16.63	2.19
SL	5	0.701	3	10.19	2.58
RT	5	0.662	4	14.45	2.63
CP	5	0.817	4	12.95	3.67
ER	5	0.452	4	11.04	2.70
AR	5	0.782	5	17.97	2.92
LL	5	0.795	3	11.33	2.09

Note: CT - financial implications / cost; (2) HE - human resource efficiency; (3) PE - procedural efficiency; (4) GP - "good practice"; (5) SL - sales; (6) RT - reputation; (7) CP- commercial pressure; (8) ER - existing government regulation; (9) AR - anticipating government regulation, and (10) LL - liability laws. SD = Standard Deviation

Estimates of the parameters

The logistic regression results (Tables 4 and 5) show that both models (FR and PL) were significant at a level of 0.01. Further, the relatively higher Pseudo R-square values (0.789 and 0.701 for FR and PL models, respectively) suggest that the models performed well.

The estimates of incentives (logits/logged odds) indicate that an increase in the scale value of an incentive by one unit will increase (positive sign)/decrease (negative sign) the ability of firms to behave more food safety responsibly. For example, in FR Model, a unit increase in the scale value of PE will increase the logged odds of switching between "very low" to "very high" categories by 1.332. Furthermore, a unit increases in the scale values for CT in this model will decrease the logged odds of switching between these two categories by 0.272, and that interpretation applies to all estimates of incentives in both models.

In the FR model, three individual incentives, namely good practice (GP), reputation (RT), and procedural efficiency (PE) were significant at $p = 0.01$, whilst none in the PL model significant at this level. Existing government regulation (ER) and sales (SL) were significant at $p = 0.05$ and $p = 0.10$, respectively, in both models. In addition, human resource efficiency (HE) in the FR model and cost/financial implications (CT) and anticipated government regulation (AR) were significant in the PL model at $p = 0.05$.

Table 4. Estimates of parameters of the Federally-registered (FR) model

Description	Variables	Estimate	Std. Error	Significance
Cut-off Points	D=1	1.171	4.276	0.784
	D=2	3.730	4.249	0.380*
	D=3	8.299	4.308	0.054*
	D=4	12.304	4.381	0.005***
Incentives	CT	-0.272	0.372	0.463
	HE	-1.006	0.310	0.001**
	PE	1.332	0.405	0.001***
	GP	1.564	0.483	0.001***
	SL	0.736	0.425	0.084*
	RT	1.380	0.447	0.002***
	CP	0.115	0.340	0.736*
	ER	-0.943	0.333	0.005**
	AR	0.245	0.370	0.508
	LL	-0.601	0.374	0.109*
Location	ON	-0.252	0.395	0.524
Firm Size	S	-0.546	0.822	0.507
	M	-1.167	0.802	0.146
	L	-1.410	0.905	0.119*
	VL	-1.630	1.115	0.144*
Activities	SG	-0.568	.570	0.319
	CB	0.228	0.419	0.586
	MF	0.345	0.477	0.469*
	ST	-0.834	0.382	0.029**
Products	BF	-0.444	0.420	0.291
	PK	0.182	0.378	0.630
	PL	0.683	0.381	0.073*
	OA	-0.472	0.603	0.433
Customers	GC	-0.119	0.447	0.790**
	FS	0.003	0.416	0.925*
	RS	0.718	0.443	0.105
	RU	0.002	0.566	0.963
	PC	0.920	0.498	0.064*
	WS	-0.557	0.423	0.189
	WI	-0.185	0.665	0.781
	PV	0.002	0.629	0.969
	IP	0.798	0.442	0.071*
	IT	0.751	0.418	0.073*

***, ** and * denote, respectively, statistical significance at 1, 5 and 10 percent.

Table 5. Estimates of parameters of the Provincially-licensed (PL) model

Description	Variables	Estimate	Std. Error	Significance
Cut-off Points	D = 1	19.481	9.158	0.033**
	D = 2	24.234	9.469	0.010*
	D = 3	30.743	9.828	0.002*
	D = 4	34.080	9.803	0.001**
Incentives	CT	-1.119	0.718	0.119**
	HE	0.270	0.726	0.710
	PE	1.119	1.049	0.286*
	GP	1.245	1.316	0.139
	SL	0.759	0.789	0.336*
	RT	1.012	1.028	0.279
	CP	0.672	0.744	0.367
	ER	-0.179	0.876	0.838**
	AR	1.554	1.019	0.127**
	LL	0.628	0.889	0.480
Location	ON	-0.258	0.797	0.747
Firm Size	VS	3.411	2.225	0.125*
	S	3.184	1.893	0.093*
Activities	CB	-1.652	1.273	0.194
	MF	-0.243	1.035	0.815
	ST	0.350	0.945	0.711*
Products	BF	1.157	1.210	0.339
	PK	0.945	1.178	0.422
	LG	-0.582	1.195	0.626
	PL	2.382	1.285	0.064*
	OA	-1.007	1.096	0.358
Customers	RS	1.632	1.016	0.108
	RU	-0.633	0.997	0.526
	PC	-0.435	1.161	0.708
	WS	0.280	1.060	0.792
	WI	-0.717	1.755	0.683*
Sales Area	PV	0.426	1.610	0.791*

***, ** and * denote, respectively, statistical significance at 1, 5 and 10%.

Results suggest that the level of significance of dummy variables used to represent firm and market-specific characteristics varied between two models. The effects on logged odds in both models were next transformed to the effects on instantaneous (marginal) probabilities. The outcome proves that GP, RT and PE had the higher effect on food safety responsive behavior of managers in Federally-registered firms (0.35, 0.31 and 0.30 respectively), and CT and AR had higher effect of that in Provincially-licensed firms (-0.27 and 0.38 respectively).

CONCLUSIONS AND POLICY IMPLICATIONS

The outcome of the study suggests that decisions at the level of the firm regarding responsiveness to food safety issues are complex and motivated by a number of individual incentives. It highlights that market-based incentives play the greatest role for the managers from firms operating in the Canadian red meat and poultry processing sector to adopt enhanced food safety controls.

The results show that both Federally-registered (FR) and Provincially-licensed (PL) firms consider their actions are triggered by the incentive that adoption of such controls is a "good practice" (GP), enhances and protects their reputation (RT), and enhances the efficiency of their physical activities (PE). Although, those from FR firms indicate that the advantages of enhanced food safety controls justified the financial implications/costs (CT), managers from the PL firms, on the contrary, indicated that such costs had a negative impact on their food safety responsiveness. The influence of particular incentives on different categories of firms varies significantly. Existing government regulations (ER), ironically, are a disincentive for FR firms to adopt enhanced food safety practices. Anticipated future government regulations (AR), however, have little effect, since most of these firms have already implemented HACCP, for example because of the requirements of their customers. Conversely, ER was not a disincentive for PL firms, whilst AR was a significant motivation to adopt enhanced food safety controls.

The results also suggest that regulatory requirements are only one of a number of incentives that motivate firms to enhance their food safety controls. In other words, the market itself has potential or willing to take part in this respect since individual firms have incentives to safeguard its reputation and internal efficiency of the firm. Consequently, the implications of the outcome of this analysis on policy are such that it suggests that policy-makers should move beyond traditional regulatory modes, for example making the adoption of food safety metasystems such as HACCP mandatory, and to implement an incentive-based regulatory system for the food processors that is sufficiently flexible to reflect differences in the incentive base of individual firms. In such a system, food safety standards and regulation need to be responsive to private incentives at the firm and sector levels, thus permitting firms to respond to and take advantage of market-based forces.

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