Quantifying the Impact of Economic Incentives on Firms' Food Safety Responsiveness: The Case of Red Meat and Poultry Processing Sector in Canada

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Abstract

This study assesses quantitatively the economic incentives for firms to adopt 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.

Key Words: food safety controls, economic incentives, adoption, food processing sectors in Canada

A selected paper presentation at the annual American Agricultural Economics Association Meeting, Denver, Colorado, August 1 – 4, 2004.

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Introduction

Although the food supply in most developed countries is generally considered to be safe (Huff and Owen, 1999), modern industrial food systems cannot fully eradicate the potential disease-causing agents in food[1]. Further, a number of high-profile 'scares' globally, have served to enhance consumer awareness and concerns about food safety (GAO/RCED, 1996)[2]. Although Canada has not experienced a major outbreak of food-borne disease in recent years, relatively 'minor' outbreaks are reported quite regularly (CFIA, 2003). Further, food safety has recently become a more prominent issue since a case of BSE in cattle was reported in Alberta in August 2003.

Estimates suggest that the costs associated with food-borne disease are substantial. For example, the Economic Research Service (ERS) of United States Department of Agriculture (USDA) estimates that the annual cost of food-borne illness and premature death in the United States is around $1.1 to $1.3 billion over 20 years (Crutchfield *et al.*, 1997). Over half of all such cases are linked to contaminated meat and poultry products (GAO/RECD, 1996). Many of these costs may only be partly imposed on food processors. However, in the presence of food safety risks, firms may realize that the direct (e.g. liability law suits) and indirect (e.g. loss of

[1] The US Centres for Disease Control and Prevention (CDC) classifies the causes of food-borne illness as follows: (1) bacterial pathogens; (2) chemical agents; (3) viral pathogens, and (4) parasite pathogens. Foods may contain a range of bacterial and pathogenic agents that are widely present in the natural environment and can occur in food through production systems, cross contamination etc. Further, microbial pathogens may enter streams and into human water supplies through feedlots or pasture run-off. Chemical agents include naturally-occurring toxins, for example paralytic shellfish poisoning and mycotoxins, and heavy metals. These chemical agents can cause a variety of gastrointestinal, neurologic, respiratory and other symptoms (Weersink *et al.*, 1998; GAO/RCED, 1996).

[2] In North America, most notable is the Jack-in-the-Box case, where four children in the Pacific North West of the US died and hundred of others became ill from eating hamburgers contaminated with *E. coli* in 1993 (Spriggs and Isaac, 2001).

reputation) costs of food safety failures are significantly greater than the costs of mitigation (i.e. costs of implementing food safety controls) (Caswell and Modjuszka, 1996). Moreover, potential consumer reactions to real or perceived food safety risks, for example “product avoidance” and “brand switching”, can provide incentives for food processors to undertake precautions to reduce food-borne hazards through production processes (Henson and Caswell, 1999).

There is an on-going debate involving both economists and policy-makers regarding the most effective and desirable mechanisms to achieve an ‘appropriate’ level of food safety. However, much of this debate has arguably tended to over-emphasize the role of government regulation and the shortcomings of the market, whilst ignoring wider economic incentives for food processors to adopt food safety controls. Further, there is little systematic evidence regarding the effectiveness of incentive and/or market-oriented mechanisms. Indeed, much of the existing analysis fails to address the most economically efficient manner in which to regulate food safety. This contradicts the fact that the major challenge facing policy-makers is the design of a system that assures consumers of a safe food supply while avoiding draconian measures that hamper the competitiveness of the food industry, by curtailing the incentives for producers with little marginal benefit from improved food safety (Henson and Caswell, 1999).

The purpose of this study was, therefore, to investigate empirically the role of alternative economic incentives for firms to adopt enhanced food safety controls and the potential impact, in turn, of firm and market-specific characteristics. This paper reports the results of the second of a two-stage research program (see Jayasinghe-Mudalige and Henson, 2003 for the outcome of the first stage) that collects and analyses data from a survey of firms in the Canadian red meat and poultry processing sector.

Literature Review

Buzby *et al.* (2001) and Loader and Hobbs (1999) suggest three elements that create incentives for firms to adopt enhanced food safety controls: (1) market forces; (2) food safety laws and regulation; and (3) product liability laws. Much of this literature has, however, downplayed the role of market-based incentives, although more recently the environmental (see, for example; Segerson and Miceli, 1998; Segerson, 1986) and food economics (see, for example Henson and Holt, 2000; Segerson, 1999) literature has begun to acknowledge the wider economic incentives that influence such firm-level behaviour.

Regulatory incentives to adopt food safety controls are provided by public legislation, where regulations vary substantially both between countries and between states/provinces within countries. Firms that are non-compliance can be subject to various penalties imposed by the courts and/or government agencies in terms of fines, product recalls and temporary or permanent closure (see, Spriggs and Isaac, 2001 on the Canadian food safety regulatory system). 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[3] (Buzby *et al.*, 2001; Holleran *et al.*, 1999). The underlying economic premise of product liability is, therefore, that people and firms have incentives to produce safer products if they must fully compensate those harmed by their products[4]. Thus, potential liability is one part of a firm's anticipated costs of operation and firms should take the optimal amount of food safety precaution as they attempt to minimize costs (Buzby and Frenzen, 1999). According to Antle (1995), both of these

[3] Here criminal and civil sanctions possess implications for the prosecution of a lawsuit, because they are characterized by two different standards of proof. The former is generally based on public regulations and statutory instruments, whilst the later is associated with non-governmental, non-regulatory approaches.

[4] Buzby and Frenzen (1999) identify three main "causes of action" associated with product liability for which plaintiffs can receive compensation: (a) strict product liability; (b) negligence; and (c) breach of express or implied warranty.

approaches is used to varying degrees to secure a safe food supply in developed countries, although with statutory safety standards used most frequently as the principal approach.

Holleran *et al*. (1999) and Holleran and Bredahl (1997) suggest that the incentives for firms to adopt food safety controls stem from both firm-driven "internal incentives" and customer/regulation-driven "external incentives". The authors indicate that such internal incentives include the costs and benefits directly associated with a firm's operational processes affected by adoption, for example improved management of the firm's activities, reduced product failure rates etc. The pressure created by suppliers and customers, the legal environment, and the extent to level which a firm penetrates a particular food markets are but a few of the external incentives affecting a firm's food safety control decision.

Unlike the economic literature on the environment, workplace safety, truth in advertising and ethics in procurement policy, for example, there is a paucity of research on the role of market and non-market incentives for food safety and/or quality controls[5]. Implementation of the ISO 9000 series of standards in various food processing sectors in the United States (see for example Mumma *et al.*, 2002; Capmany *et al.*, 2000), United Kingdom (see for example Zaibet and Bredahl, 1997; Manchester Business School, 1996), and several other countries (see for example Turner *et al.*, 2000; Carlson and Carlson, 1996) has been the focus of much of the literature that does exist. This suggests that ISO 9000 is implemented by most firms in response to market-based incentives such as internal efficiency and customer requirements, whilst both regulatory and liability incentives have played a less significant role.

[5] Nakamura *et al.*, (2001) and Henriques and Sadorsky (1995), for example, examine the incentives for a firm to formulate an environmental control plan in Japan and Canada respectively. Khanna and Damon (1998) evaluate incentives for firms to participate in the voluntary 33/50 programs for the chemical industry in the United States. Wu and Babcock (1999), Segerson and Miceli (1998), Arora and Gangopadhyay (1995) and Stranlund (1995) investigate whether voluntary agreements between firms and the government are likely to be more efficient than mandatory approaches.

Although HACCP has been subject to intense technical and economic analysis in recent years, few studies have explored empirically the wide-ranging incentives for adoption at the firm level (see for example Henson and Holt, 2000; Henson and Northen, 1998). Studies that have been undertaken, however, conclude that the impact of market, regulatory and liability incentives varies according to firm and market-specific characteristics, especially in the US and European food sectors where HACCP has increasingly become a regulatory requirement. Little such research has been undertaken in Canada, especially utilising quantitative analysis. One exception is Mehta and Wilcock (1996) that examine the potential motives for firms in the Canadian food sector to implement quality system standards such as ISO 9000.

Although these previous studies provide a good insight into the motives for food processors to adopt enhanced food safety controls, they are subject to certain limitations. For example, many lack a clearly-defined economic framework and analysis is limited to simple ranking and/or qualitative methods (for example Carlson and Carlson, 1996; Mehta and Wilcock, 1996). Further, a number disregard the effects of firm and market characteristics on adoption decisions (for example Manchester Business School, 1996). More generally, there is a need for a more rigorous economic analysis of the entire motive set faced by food processors to adopt enhanced food safety controls.

A relatively large number of previous studies use "benefit-cost analysis" to examine the overall gains to different food sectors from adopting certain food safety and quality metasystems, in particular HACCP. This literature has explored the adoption of HACCP in the US red meat and poultry processing sector (see for example Ollinger and Mueller, 2003; Golan *et al.*, 2000; Antle, 2000; Jenson and Unnevehr, 1999; Calatore and Caswell, 1999; Crutchfield *et al.*, 1997), as well as other food sectors in the US and other countries (see for example Cato and Lima dos

Santos, 2000 on the frozen shrimp industry in Bangladesh and Zaibet, 2000 on the Oman fish industry). Whilst the majority of these papers predict net gains to the sectors examined, they suggest that smaller firms typically achieve lower benefits and accrued higher costs, for example in the adoption of HACCP.

Overall, the existing literature suggests 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’, however, it is important to understand the individual incentives to implement food safety controls at the firm level and the role that regulations has on these incentives. A case in point is the meat and poultry processing sectors in US, Canada and many other developed countries (Henson and Hooker, 2001).

The current study presents a comprehensive analysis of the economic incentives, related to market, regulatory and liability forces, for food processing firms to adopt enhanced food safety controls. It is the first such analysis to be undertaken within the context of the Canadian food processing sector. Firms within this sector are differently subject to regulation at the federal, provincial and/or municipality levels. At the same time, distinct market forces play a significant role, alongside regulations, in influencing the controls that firms implement. In turn, such forces can act to improve the functioning of government regulation, and thereby diminish the incidence of non-market failures (see for example Wolf, 1986, 1979).

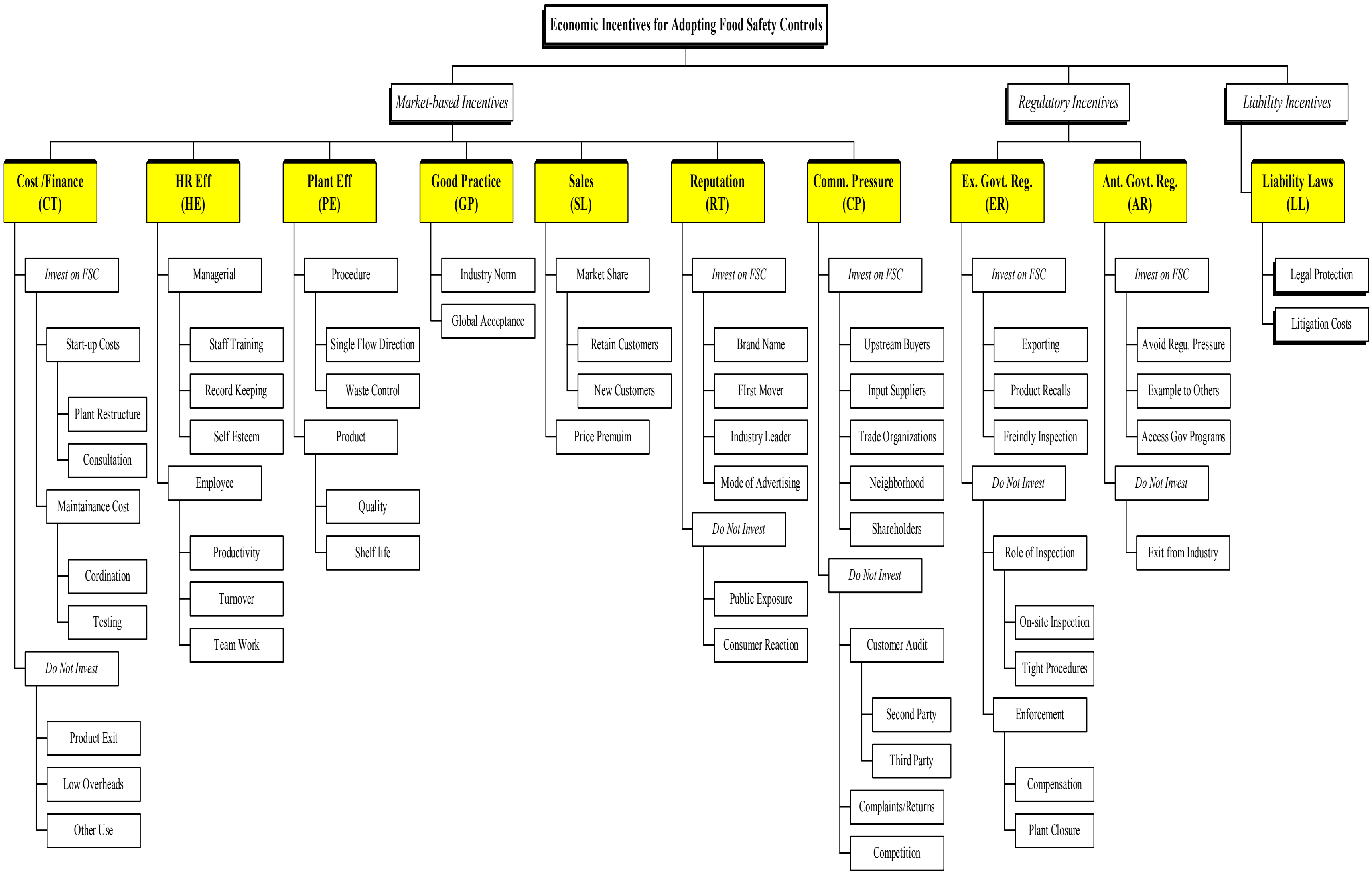
Methods

This paper presents the results of the second stage of a two-stage research program. In the first stage, a series of in-depth interviews (n=36) with quality assurance managers in meat processing 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 (Figure 1).

The second stage was designed to "quantify" the extent to which these 10 individual incentives influence firm adoption of enhanced food safety controls. 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). The data from 279 firms (representing a 34 percent response rate) were analyzed using a number of quantitative analytical methods, including Ordered Logistic Regression (OLR) and the development of an Incentive-Related Index. This paper in particular reports the results from the first of these methods.

The outcome of stage one was used to develop a conceptual framework loosely based on the models presented in Nakamura *et al.* (2001), Segerson (1999), Caswell *et al.* (1998) and certain agency models of the firm presented by Williamson (1986) and Jenson and Meckling (1976). In this framework, incentives for a manager to adopt enhanced food safety controls, and thus to be food safety responsive, is integrated into a *utility function*. Other than overall profits from the firm's operations, the "manager's utility function" is characterized by the '*intrinsic*

Figure 1 - Incentives to adopt food safety controls:



value' the manager receives from their food safety responsive behaviour. To begin, it is assumed that the decision maker of the firm *i* maximizes their utility $U_i = u\ (v, r, c)$[6], which is conditional on Y_i and I_i with respect to D_i. Thus, maximizing U_i:

$$U_i = u\ [v\ (D_i \,/ I_i),\ r\ (D_i \,/ F_i),\ c\ (D_i \,/ F_i)] \qquad (1)$$

Where D_i is the decision variable that describes the level of food safety controls adopted by firm *i*. In an attempt to identify the factors that maximize the decision maker's utility with respect to food safety (U_i), emphasis must be placed on the manager's attitudes and perceptions with respect to the incentives they face. The term $v\ (D_i | I_i)$ can, in turn, be specified to represent this[7]; that is to reflect the attitudinal and perceptual variables associated with the individual incentives (I_i) represented in Figure 1.

The terms $r(D_i | F_i)$ and $c(D_i | F_i)$ of Equation 1 denote firm *i*'s conditional revenue and cost functions, respectively, in which F_i stands for the firm and market-specific characteristics of firm *i* including (given) past managerial decisions. Thus, the profit of the firm[8] (π_i) can be characterized by $\pi_i = r(D_i | F_i) - c(D_i | F_i)$, where it is assumed that profit is only one objective, amongst others, that determine the firm's performance related to the level of food safety. Estimation of quality-related cost functions and revenue, however, poses difficulties because of unreported financial data, whilst product or factor prices are judged to be implausible (Antle, 2000; Segerson, 1999 and Caswell *et al.*, 1998). Thus, to avoid the difficulties associated with estimating the profit equation [i.e. $r(D_i | F_i) - c(D_i | F_i)$] empirically, it is assumed that these firm and market-specific characteristics reflect the firm's ability to earn profits. Similarly to

[6] Assuming u(r, c, v) is concave in its arguments.
[7] Which uses this term to explain the intrinsic value the manager of firm *i* derives from implementing recommended public and private environmental controls.

Nakamura *et al.* (2001), the maximization problem in Equation 1 is solved to obtain the following 'reduced' (*Equation 2*) and 'regression' (*Equation 3*) forms for D_i, where ε_i is the error term:

$$D_i = f\,(I_i, F_i) \qquad (2)$$

$$D_i = f\,(I_i, F_i) + \varepsilon_i \qquad (3)$$

The analysis is complicated by the fact that Canadian food processing firms implement a range of food safety practices (Baldwin *et al.,* 1999), whilst such actions are induced by numerous incentives (see for example Buzby *et al.*, 2001; Shavell, 1987) as identified in Stage One of the research, many of which are 'unobservable' at the firm level (Hair *et al.*, 1995) and highly subjective to individual managers (Buchanan, 1969). Consequently, a "Food Safety Responsiveness Index" (FSRI) was computed as the mean of the scores given in response to a set of statements regarding the firm and food safety. While accepting the difficulties associated with specifying individual incentives (I_i) in the empirical model, Confirmatory Factor Analysis (CFA) and the computation of multi-item summated scales (Henson and Traill, 2000; Hair *et al.*, 1995; De Vellis, 1991; Hughes *et al.*, 1986) were used to develop estimable variables for the incentives of interest. Firm and market-specific variables were incorporated explicitly as variables to represent F_i in the empirical model.

The individual incentives identified in stage-one were specified as "*constructs*" in the "*measurement model*". Attitudinal statements selected from the interview scripts to reflect the observable characteristics of each incentive were employed as "*indicators*" to represent these constructs. Likewise, attitudinal statements were also used as indicators of the FSRI. A

[8] It is assumed that the production function characterizes the overall profit of the firm and the level of resources allocated to produce appropriate levels of food safety satisfies the arguments of homogeneity, concavity etc.

validation item (see Henson and Traill, 2000) for each construct was also included in the questionnaire[9]. Respondents were 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. Scores for the statements were subject to a number of scale purification techniques. Subsequently, summated scores were derived for each incentive and the FSRI.

Given the choice of variables based on the results of Stage One, the *a priori* theoretical inter-relationships between variables and the practical constraints posed by interpretation of an ordered logistic regression (see, for example Borooah, 2002 and Pampel, 2000, Greene, 2000), the following specification of the empirical model was applied (Table 1):

$$D_i = \beta_0 + \beta_1 * CT + \beta_2 * HE + \beta_3 * PE + \beta_4 * GP + \beta_5 * SL + \beta_6 * RT + \beta_7 * CP + \beta_8 * ER + \beta_9 * AR + \beta_{10} * LL + \sigma_1 * FR + \sigma_2 * ON + \sigma_3 * VS + \sigma_4 * S + \sigma_5 * M + \sigma_6 * L + \sigma_2 * VL + \sigma_3 * SG + \sigma_4 * CB + \sigma_5 * MF + \sigma_6 * ST + \sigma_7 * BF + \sigma_8 * PK + \sigma_9 * LG + \sigma_{10} * PL + \sigma_{11} * OA + \sigma_{12} * GC + \sigma_{13} * FS + \sigma_{14} * RS + \sigma_{15} * RU + \sigma_{16} * PC + \sigma_{17} * WS + \sigma_{18} * WI + \sigma_{19} * LC + \sigma_{20} * PV + \sigma_{21} * IP + \sigma_{22} * IT + \varepsilon_i \quad (4)$$

Four separate models were specified to represent Federally-registered (FR) and Provincially-licensed (PL) meat processing firms in Canada as a whole and Ontario specifically, namely: (a) ALL-PR consists of both FR and PL firms in Canada (n = 251); (b) ALL-ON consists of both FR and PL firms in Ontario (n = 118); (c) FR-PR consists of only FR firms in Canada (n = 182), and (d) PL-PR consists of only PL firms in Ontario (n = 69). Maximum Likelihood methods were used to estimate the parameters of the models using PLUM logistic regression.

[9] In accordance with recommended good practice associated with conducting CFA, these statements were mixed randomly and presented in the questionnaire without the relevant "construct" heading (i.e. associated incentive) to avoid potential biased. Care was taken to avoid unduly lengthy statements, double negatives, double-barrelled statements and jargon, since these are all potential sources of confusion. A number of statements were intentionally 'inverted' to ensure that respondents thought about each question rather than hurriedly gave the same response to each. At the end of pilot testing, there were 72 statements. Thus, five indicators per construct x 10 constructs + 12 statements to estimate FSRI + 10 validation items were included in the final questionnaire.

Table 1 - Variables defined for the empirical Model:

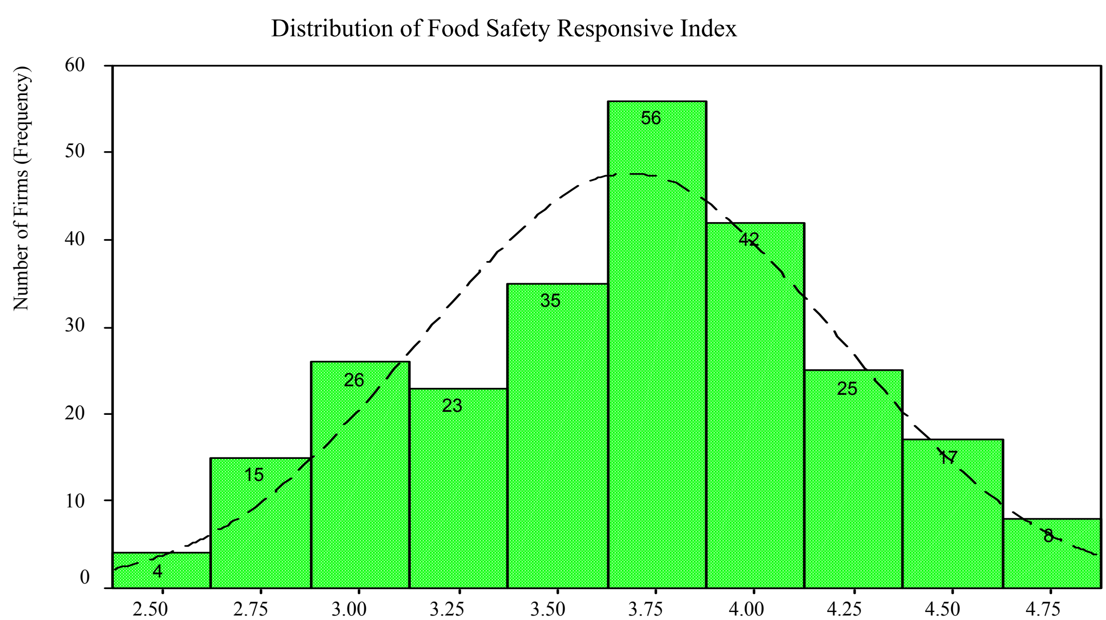
Symbol Used	Corresponding Variable	Remarks
	Dependent Variable and Parameter Estimates	
D_i	Ordered variables derived from Food Safety Responsive Index	D = 1 to 5
δ	Cut-off points for ordered dependent variables	
β_0	The intercept term	
β_i	The estimates for incentives	Explanatory variables
σ_i	The estimates for firm- and market-specific characteristics	Dummy variables
ε_i	The stochastic error term	
	Continuous Explanatory Variables to Represent Incentives (Y_i)	
CT	Financial Implications/Cost	
HE	Human Resource Efficiency	
PE	Procedural Efficiency	
GP	Good Practice	
SL	Sales	
RP	Reputation	
CP	Commercial Pressure	
ER	Existing Government Regulations	
AR	Anticipating Government Regulations	
LL	Liability Laws	
	Dummy Variables to Represent Firm- and Market-specific Characteristics (Xi)	
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		
LC	Within the local municipality	LC = 1; otherwise = 0
PV	Within the Province firm operates	PV = 1; otherwise = 0
IP	Inter-provincial sales	IP = 1; otherwise = 0
IT	Exports to the USA and other countries	IT = 1; otherwise = 0

Estimates of logged odds (logits) and the probabilities derived for the independent variables of each model were used to interpret the nature of each explanatory variable (i.e. continuous or dummy) and the relative size and sign of its effect.

Results

The process of quantifying each incentives influence on food safety responsiveness involved the derivation of ordered dependent variables, estimation of scale values for each incentive, and the use of Ordered Logistic Regression (OLR) techniques to estimate coefficients for the influence of the value of the FSRI. The first step towards deriving the dependent variable was to estimate the FSRI for each firm using the scores given by respondents (n = 251) to 12 attitudinal statements[10]. The distribution of the FSRI amongst the firms ranged from 2.5 (the lowest) to 4.83 (the highest), with a mean of 3.68 and Standard Deviation of 0.52 (Figure 2).

Figure 2 - Distribution of values of the food safety responsive index:



Next, five ordered dependent variables (D_i = 1 to 5) were developed for the purpose of the OLR analysis using the "lower" and "upper" limits for the FSRI (Table 2). These five categories exemplify that, all else being equal, it is more 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[11].

Table 2 - Ordered dependent variables to represent firms' food safety responsiveness:

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.

The scale values for the individual incentives were included as explanatory variables in the models. In an attempt to eliminate superfluous items, the *Cronbach Alpha* (Cronbach, 1951) of each statement was estimated (Table 3). The next step of the scale purification process was to assess the unidimensionality of statements using Principal Axis Factoring. The results[12] indicated that the scales were indeed unidimensional; except for two statements the factor loadings were

[10] The scores given by respondents to a number of statements were re-inverted before calculating the index. To evaluate the validity, unidimensionality and reliability of these statements, the standard tests were conducted.
[11] The distribution of firms within the five categories of dependent variables in the ALL-PR and ALL-ON samples showed a similar pattern with a mean of 2.9 (p = 0.58). However, the distribution of the FR-PR sample showed a 'left-skewed' pattern with a mean of 3.3 (p = 0.66), whilst there was a 'right-skew' in the PL-PR sample with a mean of 2.1 (p = 0.42). This suggests that the majority of FR firms were "medium" to "highly" food safety responsive, whist most PL firms were more "highly" food safety of responsiveness.
[12] The detail results are not reported considering the lengthiness of paper, however, can be supplied to any interested reader upon request from the authors.

greater than 0.35. Amongst the 38 statements selected through the reliability analysis, factor loadings of 33 (87%) were more than 0.4.

Table 3 – Procedures and the results of testing scale reliability:

Incentives	No of Items Included in Questionnaire	Cronbach Alpha Value	Items Remained in the Model	Mean Score	Standard Deviation
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	0.195	3	11.33	2.09

Finally, construct validity[13] was measured (Cronbach and Meehl 1955), with the single validation item included for each incentive applied as the alternative measurement instrument to develop the MTMM matrix (Campbell and Fiske, 1959). The results indicated that majority of coefficients were 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.

The logistic regression results (Table 4 and Annexes 1 to 3) show that the four models were significant at a level of 0.01. Further, the relatively higher *Pseudo R-square* value suggests that the models performed well. The size of each coefficient estimate relative to its standard error provides the basis for tests of significance (Borooah, 2002).[14]

[13] No explicit tests were undertaken to test the content and predictive validity of the scales related to incentives. The evidence for content validity was provided by the comprehensive review of literature and in-depth interviews.

Table 4 - Results of logistic regression analysis for ALL-PR (Model I):

Description	Variables	Estimate	Std. Error	Wald Statistic	Significance
Cut-off Points	D = 1	1.845	3.209	0.331	*0.565*
	D = 2	5.020	3.213	2.441	*0.118*
	D = 3	9.335	3.255	8.228	*0.004****
	D = 4	13.059	3.327	15.404	*0.000****
Incentives	CT	-0.423	0.276	2.342	*0.126*
	HE	-0.646	0.246	6.874	*0.009****
	PE	1.177	0.337	12.172	*0.000****
	GP	1.474	0.403	13.375	*0.000****
	SL	0.613	0.309	3.950	*0.047***
	RT	1.201	0.372	10.440	*0.001****
	CP	0.006	0.263	0.058	*0.810*
	ER	-0.511	0.277	3.396	*0.065**
	AR	0.485	0.313	2.399	*0.121*
	LL	-0.260	0.291	0.796	*0.372*
Type	FR	-1.338	0.748	3.199	*0.074**
Location	ON	-0.454	0.318	2.039	*0.153*
Firm Size	S	-0.761	0.513	2.203	*0.138*
	M	-1.663	0.592	7.896	*0.005****
	L	-1.840	0.696	6.986	*0.008****
	VL	-1.940	0.945	4.211	*0.040***
Activities	SG	-0.615	0.542	1.288	*0.256*
	CB	0.005	0.370	0.024	*0.877*
	MF	0.227	0.371	0.373	*0.541*
	ST	-0.843	0.319	6.978	*0.008****
Products	BF	-0.468	0.364	1.651	*0.199*
	PK	0.258	0.327	0.623	*0.430*
	LG	1.067	0.608	3.077	*0.079**
	PL	0.558	0.338	2.716	*0.099**
	OA	-0.445	0.447	0.992	*0.319*
Customers	GC	-0.262	0.401	0.428	*0.513*
	FS	-0.004	0.386	0.012	*0.913*
	RS	0.443	0.344	1.663	*0.197*
	RU	-0.135	0.418	0.104	*0.747*
	PC	0.474	0.389	1.481	*0.224*
	WS	-0.635	0.351	3.270	*0.071**
	WI	0.008	0.503	0.028	*0.867*
Sales Area	LC	0.673	0.379	3.149	*0.076**
	PV	0.327	0.524	0.389	*0.533*
	IP	0.733	0.408	3.228	*0.072**
	IT	0.909	0.401	5.153	*0.023***
Model F value	*330.64****				
Degrees of Freedom	*41*				
Pseudo R-square	*0.776*				

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

[14] The *cut-off points (*threshold values*)* indicate the cumulative logits when the independent variables equal zero. These points are necessary for calculating predicted values but are relatively uninteresting.

Four individual incentives, namely good practice (GP), reputation (RT), procedural efficiency (PE), and human resource efficiency (HR) were significant in Model I (ALL-PR) at $p = 0.01$ and two others, sales (SL) and existing regulation (ER), were significant at $p = 0.05$ and 0.1 respectively. Indeed, GP and RT were significant at $p = 0.01$ in all models, except Model IV in which none of the incentives were significant[15]. The results for the FR-PR sample (Model III) were similar to those for ALL-PR. Financial implications/cost (CT) was significant at $p = 0.10$ level in the ALL-ON sample (Model II).

The logged odds/logits calculated for independent variables in the four models are presented in Table 5. The results highlight that these effects varied significantly between incentives. For example, an increase in the scale value of RT by one unit in Model I increased the logged odds of switching from "very low" to "very high" on the FSRI[16] by 1.20. However, with respect to SL, a unit increase in the scale value increased the logged odds of switching between these categories of only 0.61. Furthermore, a unit increases in the scale values for CT and LL decreased the logged odds of switching from “very low” to “very high” food safety responsiveness by 0.423 and 0.260 respectively.

In the case of the dummy variables, a change in one unit implicitly compares the indicator group to the reference or omitted group (see, Borooah, 2002). Thus, the negative coefficients of 0.761 and 1.84 for “small” and “large” firms in Model I indicate that, *ceteris paribus,* the logged odds of moving from “very low” to “very high” food safety responsiveness were 0.76 and 1.80 lower than for very small firms[17].

[15] Long (1997) suggests that logistic regression analysis techniques can provide biased results in the case of small samples. Therefore, the results from the PL-PR sample (n = 69) must be treated with caution.

[16] In fact, this reduction was the same regardless of the food safety responsiveness category (D_i) under scrutiny. Therefore, it's more correct to say that a given incentive increases/decreases the logit of "very low" versus "very high".

[17] However, this is not to say that every small or large firm had a higher probability of being food safety responsive than every very small firm in that particular sample. Rather the correct interpretation is that, given two firms that

Table 5 - Logged odds of the models:

Description	Variables	Model 1 ALL-PR	Model II ALL-ON	Model III FR-PR	Model IV PL-PR.
Incentives	CT	-0.423	-0.855	-0.272	-1.119
	HE	-0.646	0.472	-1.006	0.270
	PE	1.177	1.177	1.332	1.119
	GP	1.474	2.689	1.564	1.945
	SL	0.613	0.387	0.736	0.759
	RT	1.201	1.719	1.380	1.112
	CP	0.006	0.376	0.115	0.672
	ER	-0.511	-0.334	-0.943	-0.179
	AR	0.485	-0.228	0.245	1.554
	LL	-0.260	0.008	-0.601	0.628
Type	FR	-1.338	-2.108	NA	NA
Location	ON	-0.454	NA	-0.252	-0.258
Firm Size	VS	NA	2.491	NA	3.411
	S	-0.761	1.673	-0.546	3.184
	M	-1.663	0.590	-1.167	NA
	L	-1.840	-0.641	-1.410	NA
	VL	-1.940	NA	-1.630	NA
Activities	SG	-0.615	-1.549	-0.568	NA
	CB	0.005	-0.413	0.228	-1.652
	MF	0.227	1.499	0.345	-0.243
	ST	-0.843	-1.174	-0.834	0.350
Products	BF	-0.468	-1.014	-0.444	1.157
	PK	0.258	-1.025	0.182	0.945
	LG	1.067	0.731	NA	-0.582
	PL	0.558	-0.503	0.683	2.382
	OA	-0.445	-1.780	-0.472	-1.007
Customers	GC	-0.262	-0.327	-0.119	NA
	FS	-0.004	0.742	0.003	NA
	RS	0.443	0.759	0.718	1.632
	RU	-0.135	-0.717	0.002	-0.633
	PC	0.474	1.591	0.920	-0.435
	WS	-0.635	-0.788	-0.557	0.280
	WI	0.008	0.726	-0.185	-0.717
Sales Area	LC	0.673	1.688	0.351	0.426
	PV	0.327	0.720	0.002	1.125
	IP	0.733	0.730	0.798	NA
	IT	0.909	1.196	0.751	NA

NA – This particular estimate was not available since the corresponding variable did not enter the model.

were similar in respect of every characteristic *except* firm size, the larger firms was less likely to be in a higher category than a smaller firm.

Furthermore, the results indicate that FR firms (Model III) that export their products to international markets (IT) were 0.75 times more likely to be highly food safety responsive than those firms that did not export their products. Moreover, firms that engaged in slaughtering activities (SG) in Ontario (Model II) were 1.55 times less likely to be highly food safety responsive than those firms that did not slaughter. In the same model, firms that manufactured processed products (MG) were 1.5 times more likely to be highly food safety responsive than those firms that did not process.

The effects on logged odds were next transformed to the effects on instantaneous (marginal) probabilities[18] (Table 6). The outcome suggests that GP, RT and PE had the higher effect in the ALL-PR model. Both ER and CT showed negative effects in this model.

Table 6 – Instantaneous/marginal probabilities (partial derivatives):

Incentives	Model 1 ALL-PR	Model 2 ALL-ON	Model 3 FR-PR	Model 4 PL-PR.
CT	-0.10	-0.21	-0.06	-0.27
HE	-0.16	0.11	-0.23	0.07
PE	0.29	0.29	0.30	0.27
GP	0.36	0.66	0.35	0.47
SL	0.15	0.09	0.17	0.18
RT	0.29	0.42	0.31	0.27
CP	0.00	0.09	0.03	0.16
ER	-0.12	-0.08	-0.21	-0.04
AR	0.12	-0.06	0.05	0.38
LL	-0.06	0.00	-0.13	0.15

This method works best with continuous variables for which small changes in the independent variables that define the tangent have meaning. However, since the relevant change occurs from 0 to 1 for dummy variables, the tangent line for small changes in these variables

[18] Since the relationships between the independent variables and probabilities are non-linear and non-additive, they cannot be fully represented by a single coefficient. The effect on the probabilities has to be identified at a particular value or set of values. For the purpose of this analysis, 0.58 was taken as the mean probability of the dependent variable (p) for Models I and II and 0.66 and 0.42 for Models III and IV.

makes less sense. To overcome this shortcoming the "predicted probabilities" were calculated (Table 7) using the methods of Borooah (2002) and Pampel (2000).

Table 7 - Predicted marginal probabilities:

Description	Variables	Model 1 ALL-PR	Model 2 ALL-ON	Model 3 FR-PR	Model 4 PL-PR.
Incentives	CT	-0.11	-0.21	-0.06	-0.23
	HE	-0.16	0.11	-0.24	0.07
	PE	0.24	0.24	0.22	0.27
	GP	0.28	0.37	0.24	0.42
	SL	0.14	0.09	0.14	0.19
	RT	0.24	0.31	0.23	0.27
	CP	0.00	0.09	0.03	0.17
	ER	-0.13	-0.08	-0.23	-0.04
	AR	0.11	0.06	0.05	0.35
	LL	-0.06	0.00	-0.14	0.16
Type	FR	-0.31	-0.44	NA	NA
Location	ON	-0.11	NA	-0.06	-0.06
Firm Size	VS	NA	0.36	NA	0.54
	S	-0.19	0.30	-0.13	0.53
	M	-0.37	0.13	-0.28	NA
	L	-0.40	-0.16	-0.34	NA
	VL	-0.41	NA	-0.38	NA
Activities	SG	-0.15	-0.35	-0.14	NA
	CB	0.00	-0.10	0.05	-0.30
	MF	0.05	0.28	0.07	-0.06
	ST	-0.21	-0.28	-0.20	0.09
Products	BF	-0.12	-0.25	-0.11	0.27
	PK	0.06	-0.25	0.04	0.23
	LG	0.22	0.16	NA	-0.13
	PL	0.13	-0.12	0.13	0.47
	OA	-0.11	-0.39	-0.11	-0.21
Customers	GC	-0.06	-0.08	0.03	NA
	FS	0.00	0.16	0.00	NA
	RS	0.10	0.17	0.14	0.37
	RU	-0.03	-0.18	0.00	-0.14
	PC	0.11	0.29	0.17	-0.10
	WS	-0.16	-0.19	-0.13	0.07
	WI	0.00	0.16	-0.04	-0.16
Sales Area	LC	0.15	0.30	0.07	0.11
	PV	0.08	0.16	0.00	00.27
	IP	0.16	0.16	0.15	NA
	IT	0.19	0.24	0.14	NA

NA – This particular estimate was not available since the corresponding variable did not enter into the model

Conclusions:

As stated by Veeman (1999), there has been a paucity of economic analysis of food safety controls in Canada. Indeed, this is the first economic analysis of the incentives for Canadian food processors to adopt enhanced food safety controls, such as HACCP. The results suggest that decisions at the level of the firm regarding responsiveness to food safety issues are complex and motivated by a number of individual incentives. One of the most important outcomes of the analysis is that market-based incentives play the greatest role with respect to the level of food safety controls adopted by firms in the Canadian meat and poultry processing sector. Both Federally-registered (FR) and Provincially-licensed (PL) firms in the considered 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), as the most important incentives for the adoption of enhanced food safety controls. The market-based incentives of increased sales (SL) and commercial pressure (CP) were important for FR firms, but less so for PL firms. Although, FR firms judged that the advantages of enhanced food safety controls justified the financial implications/costs (CT), 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. This reflects the fact that the Ontario government, in particular, is moving to induce HACCP implementation in the meat and poultry processing sector though its “HACCP Advantage” program. For both types of firms, existing liability laws (LL) strongly motivate the adoption of enhanced food safety controls.

To some extent these findings contradict previous studies of HACCP implementation, which suggest that regulatory requirements are paramount. The outcome of this analysis suggests that regulatory requirements are only one of a number of incentives that motivate firms to enhance their food safety controls. The challenge for policy-makers is, therefore, to move beyond traditional regulatory modes and to implement an incentive-based regulatory system 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. Recent reforms at the Federal and Provincial levels in Canada, for example mandating HACCP in Federally-registered plants and the implementation of a voluntary HACCP standard in Ontario are part of this.

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Annex 1 - Results of logistic regression analysis for ALL-ON (Model II):

Description	Variables	Estimate	Std. Error	Wald Statistic	Significance
Cut-off Points	D = 1	10.535	6.644	2.514	*0.113*
	D = 2	16.106	6.887	5.469	*0.019*
	D = 3	21.917	7.071	9.607	*0.002****
	D = 4	27.084	7.427	13.298	*0.000****
Incentives	CT	-0.855	0.511	2.794	*0.095**
	HE	0.472	0.399	1.395	*0.238*
	PE	1.177	0.601	3.834	*0.050***
	GP	2.689	0.915	8.632	*0.003****
	SL	0.387	0.567	0.466	*0.495*
	RT	1.719	0.880	3.819	*0.051**
	CP	0.376	0.497	0.574	*0.449*
	ER	-0.334	0.572	0.340	*0.560*
	AR	-0.228	0.616	0.137	*0.711*
	LL	0.008	0.620	0.017	*0.896*
Type	FR	-2.108	1.516	1.935	*0.164*
Firm Size	VS	2.491	1.613	2.385	*0.122*
	S	1.673	1.756	0.908	*0.341*
	M	0.590	1.461	0.163	*0.686*
	L	-0.641	1.348	0.226	*0.634*
Activities	SG	-1.549	1.173	1.744	*0.187*
	CB	-0.413	0.727	0.322	*0.570*
	MF	1.499	0.687	4.768	*0.029***
	ST	-1.174	0.623	3.556	*0.059**
Products	BF	-1.014	0.647	2.461	*0.117*
	PK	-1.025	0.634	2.614	*0.106*
	LG	0.731	1.059	0.477	*0.490*
	PL	-0.503	0.684	0.541	*0.462*
	OA	-1.780	0.849	4.395	*0.036***
Customers	GC	-0.327	0.793	0.170	*0.680*
	FS	0.742	0.764	0.943	*0.331*
	RS	0.759	0.604	1.580	*0.209*
	RU	-0.717	0.803	0.797	*0.372*
	PC	1.591	0.686	5.380	*0.020***
	WS	-0.788	0.629	1.569	*0.210*
	WI	0.726	0.921	0.621	*0.431*
Sales Area	LC	1.688	0.727	5.395	*0.020***
	PV	0.720	0.981	0.539	*0.463*
	IP	0.730	0.859	0.722	*0.396*
	IT	1.196	0.802	2.224	*0.136*
Model F value	*200.71****				
Degrees of Freedom	*40*				
Pseudo R-square	*0.868*				

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

Annex 2 - Results of logistic regression analysis for FR-PR (Model III):

Description	Variables	Estimate	Std. Error	Wald Statistic	Significance
Cut-off Points	D = 1	1.171	4.276	0.075	*0.784*
	D = 2	3.730	4.249	0.771	*0.380*
	D = 3	8.299	4.308	3.710	*0.054**
	D = 4	12.304	4.381	7.888	*0.005****
Incentives	CT	-0.272	0.372	0.537	*0.463*
	HE	-1.006	0.310	10.501	*0.001***
	PE	1.332	0.405	10.837	*0.001****
	GP	1.564	0.483	10.494	*0.001****
	SL	0.736	0.425	2.995	*0.084**
	RT	1.380	0.447	9.521	*0.002****
	CP	0.115	0.340	0.114	*0.736*
	ER	-0.943	0.333	8.026	*0.005****
	AR	0.245	0.370	0.438	*0.508*
	LL	-0.601	0.374	2.573	*0.109*
Location	ON	-0.252	0.395	0.406	*0.524*
Firm Size	S	-0.546	0.822	0.441	*0.507*
	M	-1.167	0.802	2.115	*0.146*
	L	-1.410	0.905	2.430	*0.119*
	VL	-1.630	1.115	2.140	*0.144*
Activities	SG	-0.568	.570	0.992	*0.319*
	CB	0.228	0.419	0.297	*0.586*
	MF	0.345	0.477	0.524	*0.469*
	ST	-0.834	0.382	4.759	*0.029***
Products	BF	-0.444	0.420	1.113	*0.291*
	PK	0.182	0.378	0.233	*0.630*
	PL	0.683	0.381	3.212	*0.073**
	OA	-0.472	0.603	0.614	*0.433*
Customers	GC	-0.119	0.447	0.071	*0.790*
	FS	0.003	0.416	0.009	*0.925*
	RS	0.718	0.443	2.624	*0.105*
	RU	0.002	0.566	0.002	*0.963*
	PC	0.920	0.498	3.419	*0.064**
	WS	-0.557	0.423	1.729	*0.189*
	WI	-0.185	0.665	0.077	*0.781*
Sales Area	LC	0.351	0.437	0.645	*0.422*
	PV	0.002	0.629	0.002	*0.969*
	IP	0.798	0.442	3.259	*0.071**
	IT	0.751	0.418	3.222	*0.073**
Model F value	*189.54****				
Degrees of Freedom	*39*				
Pseudo R-square	*0.800*				

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

Annex 3 - Results of logistic regression analysis for PL-PR (Model IV):

Description	Variables	Estimate	Std. Error	Wald Statistic	Significance
Cut-off Points	D = 1	19.481	9.158	4.525	*0.033***
	D = 2	24.234	9.469	6.550	*0.010****
	D = 3	30.743	9.828	9.785	*0.002***
	D = 4	34.080	9.803	12.086	*0.001***
Incentives	CT	-1.119	0.718	2.428	*0.119*
	HE	0.270	0.726	0.138	*0.710*
	PE	1.119	1.049	1.136	*0.286*
	GP	1.945	1.316	2.184	*0.139*
	SL	0.759	0.789	0.925	*0.336*
	RT	1.112	1.028	1.170	*0.279*
	CP	0.672	0.744	0.815	*0.367*
	ER	-0.179	0.876	0.042	*0.838*
	AR	1.554	1.019	2.326	*0.127*
	LL	0.628	0.889	0.499	*0.480*
Location	ON	-0.258	0.797	0.104	*0.747*
Firm Size	VS	3.411	2.225	2.351	*0.125*
	S	3.184	1.893	2.830	*0.093**
Activities	CB	-1.652	1.273	1.685	*0.194*
	MF	-0.243	1.035	0.055	*0.815*
	ST	0.350	0.945	0.137	*0.711*
Products	BF	1.157	1.210	0.914	*0.339*
	PK	0.945	1.178	0.644	*0.422*
	LG	-0.582	1.195	0.237	*0.626*
	PL	2.382	1.285	3.435	*0.064**
	OA	-1.007	1.096	0.845	*0.358*
Customers	RS	1.632	1.016	2.580	*0.108*
	RU	-0.633	0.997	0.403	*0.526*
	PC	-0.435	1.161	0.141	*0.708*
	WS	0.280	1.060	0.070	*0.792*
	WI	-0.717	1.755	0.167	*0.683*
Sales Area	LC	0.426	1.610	0.070	*0.791*
	PV	1.125	1.683	0.447	*0.504*
Model F value	*91.58****				
Degrees of Freedom	*31*				
Pseudo R-square	*0.701*				

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