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Motives for Firms to Adopt Solid Waste Management Controls: The Case of Food Processing Sector in Sri Lanka

Udith Jayasinghe-Mudalige[1] and Menuka Udugama[2]

ABSTRACT

This study offers an empirical analysis of the economic incentives available for food processing firms in Sri Lanka to adopt environmental controls for solid waste management. A series of in-depth interviews (n=325) were carried out with managers responsible for environmental quality in five types of food processing firms (coconut-based products, essential oils, non-alcoholic beverages, processed fruits and vegetables, and other processed products). Confirmatory Factor Analysis techniques were applied to the data to quantify the effect of six market-based incentives (cost/financial implications, sales, reputation, commercial pressure, human resources and technical efficiency), two regulatory incentives (existing and anticipated government regulations), and the liability incentive on the firm's adoption of solid waste management practices. The level of adoption of environmental practices at the firm level is low -- on average firms adopt only 1.2 compared to the recommended eight different possible practices. Costs of adoption and perceived improvements in technical efficiency are two factors that motivate adoption. Liability laws and anticipated future regulations also matter. The analysis suggests that older and larger firms are more responsive to environmental considerations. Interestingly, export oriented firms do not do better than domestic firms.

Key words: *economic incentives, environmental compliance, food processing firms, regulation, solid waste management, Sri Lanka*

INTRODUCTION

Environmental economics literature suggests that incentive-based policies such as taxes and tradable permits can be more efficient than command and control type regulations such as technology standards that require each and every firm, irrespective of the characteristics of the firm, to adopt the same abatement technology and abate to the same level. There are three broad ways to maintain environmental quality at the level of firm, which include:: different types of government regulation that affect incentives for abatement and the associated costs; informal regulations by citizens and market characteristics that can lead firms to improve environmental performance, and the voluntary environmental protection, that is to be willingly carried out by a firm on its own (*Hettige et al. 1996*).

Despite weak or non-existent formal regulation and enforcement of environmental standards, many firms operatting in South and Southeast Asia are clean (*Hartman, Huq and Wheeler 1997*). To account for the extreme variation among firms, three sets of factors affecting pollution intensity were suggested including: plant characteristics; economic considerations, and external pressure from the government and private stakeholders. Further, market-based actions were suggested in general, to be more effective than government oriented "first best" solutions to deal with the problems associated with public goods (*Segerson and Miceli 1998*; *Weersink et al. 1998*). However, both economists and policymakers are less effective in addressing the predictable failures of public policy and of government efforts to remedy the market's shortcomings.

Indeed, most studies place too much emphasis on the shortcomings of the market, while ignoring such occurrences in the government. Both of these parties have the general tendencies to over-estimate the advantages that come from government regulation, and this belief, even if justified, does no more than to suggest that government regulation should be curtailed (*Coase 1960*; *Wolf 1986*). The inability of markets and government alone to provide efficient remedies for economic hazards, in turn, suggests that a collaborative action of both may be imperative to achieve favorable "second best" solutions, especially for the cases showing public good characteristics that require environmental quality management.

Moreover, Coasian solutions may not materialize even if property rights can be assigned to victims or firms due to high transactions costs and problems of collective action. It is also difficult to formulate a set of appropriate policies that can be put into practice since there is limited knowledge of the level and nature of economic incentives available to firms (*Weersink et al. 1998*). Solid waste management covers the control of generation, storage, collection, transfer and

[1] Professor (Chair), Department of Agribusiness Management, Faculty of Agriculture & Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), Sri Lanka, 60170. E-mail: udith@hotmail.com (corresponding author)
[2] Lecturer, Department of Agribusiness Management, Faculty of Agriculture & Plantation Management, Wayamba University of Sri Lanka

transport processing, and disposal of solid waste in a manner that is in accordance with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations that is also responsive to public attitudes (*Tchobanaglous et al. 1997*). The best estimate of total municipal solid waste generation in Sri Lanka was around 6400 mt d^{-1} in 2005 (*UNEP 2005*) while the generated amount far outweighs collection amounts in many areas of the country (*Bandara and Hettiarachchi 2008*). Practice, concepts and strategies adopted by firms to manage their waste had weakness due to the poor coordination among other factors such as regulations, technology and institutions (*Munksgaard and Pedersen 2001*).

This study seeks to understand why some firms do better than others in managing environmental quality. What explains the differences in adoption of enhanced environmental management at the firm level? In adopting environmental practices, do firms respond to external pressures, government regulations or some market based incentives? The specific objectives of the study are to: identify the economic incentives for food processing firms in Sri Lanka to adopt various environmental controls to manage solid waste; to quantify the extent to which these individual incentives motivate firms to adopt different types of controls; and to assess the impact of firm and of market characteristics on adoption of waste control practices.

In Sri Lanka, the food processing industry contributes about 7.9 % to the Gross Domestic Product (GDP) and is responsible for around 44 % of the total manufacturing value-added from 18 different sub-sectors that employed some 215,000 individuals in 2011. Unfortunately, the generation and accumulation of solid waste from this sector has become a growing problem. The problem of generation and accumulation of solid waste from households and various industries has surfaced as a major concern in Sri Lanka, which is exacerbated by an absence of proper management systems at the firm and household levels and by the existence of a large number of food processing industries. However, data pertaining to waste accumulation from industries reveal that the real problem is the composition of waste and the haphazard disposal practices of individual firms. Some 57 % of waste generated in the country is short-term bio-degradable waste and 6 % is classified as long-term "bio-degradable" materials while the remaining is more difficult to classify and dispose (*MENR 2005*).

The legal framework for SWM in Sri Lanka is provided under the Local Government Act. The local authorities are in charged with the responsibility of collection and disposal of solid waste at the municipal, urban and Pradeshiya Sabha Sabha (local government) level. Despite all the formal regulations in placed, effective enforcement of formal regulations aiming the management of solid and liquid waste is very poor. With this, the Ministry of Environment and Natural Resources (MENR) has designed policies to encourage firms to adopt effective and sustainable solid waste management practices (SWMP) through waste avoidance/reduction, reuse and recycling, and final disposal. The MENR under its recently formulated 'National Strategy for Solid Waste Management' has introduced a number of specific procedures and specifically assessed the extent to which firms have adopted these different practices in the food processing sector. None of these practices are purely "incentive-based policies" since they do not relate to specific instruments (e.g. taxes or penalties for non-compliance). Rather, they have the characteristics of "command and control" type standards. Nevertheless, these practices are not mandatory and it is not clear why firms choose to either adopt some practices or not.

METHODS

Conceptual Framework

There are three social processes, namely: market; political and judicial that can influence firms in implementing environmental management controls (**Figure 1**).

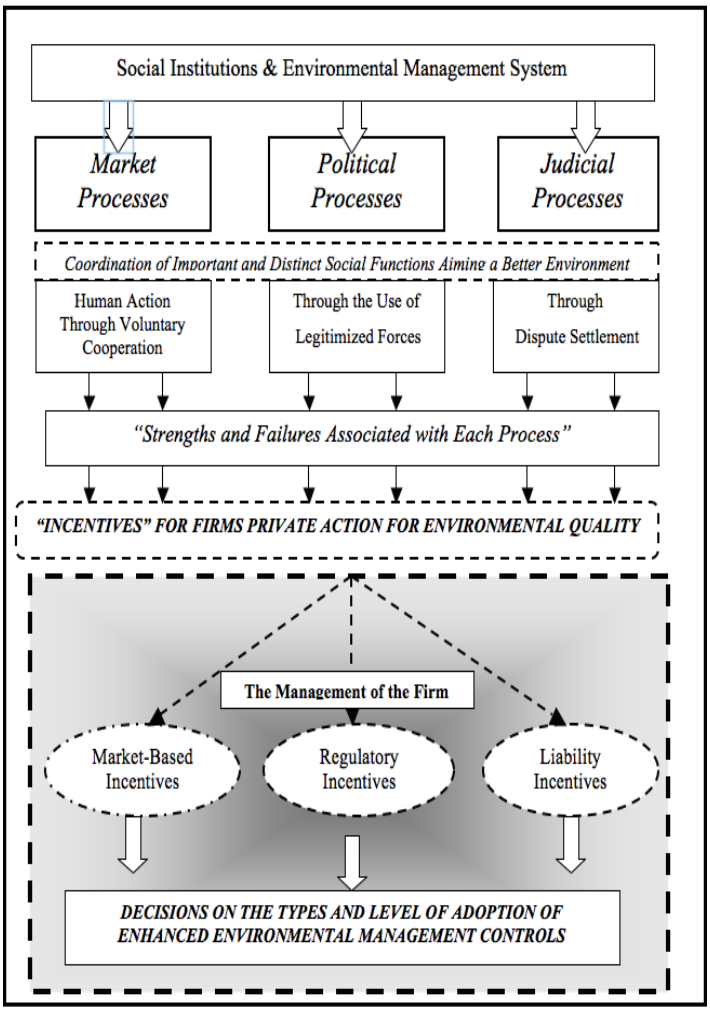

Figure 1. Conceptual framework.

Market processes help coordinate human action of firms through voluntary cooperation because of market pressures. In the case of environmental quality and the food sector, for example, ISO 14000 series of standards and enterprise-oriented and customer-specific practices may be adopted by firms voluntarily or quasi- voluntarily (i.e. based on the recommendation of trade or industry organizations). The political process contributes by offering a legal framework and through enforcement. In Sri Lanka, the public statutory and regulatory requirements of the National, Provincial and Municipal governments satisfy this requirement. Along with these, judicial process contributes through dispute mediation. This study was anchored on the theoretical explanations put forward by *Caswell et al.* (*1998*) and *Segerson* (*1999*) to derive the conceptual framework along with the set hypotheses and the empirical model.

Assuming that the environmental policy of a firm that works to create a 'waste-free non-polluted environment is characterized by the utility function $U_i = u\ [v\ (D_i|I_{ji}, F_{ki})]$ of the decision maker/management of the firm *i*(where $i = 1, 2, 3 \ldots n$) and u (v) is concave in its arguments. The management of the firm is responsible for complying with the regulatory requirements and may also adopt various strategies voluntarily to manage waste. Thus, *v* represents the overall gains to the firm through its responsible behavior towards environment quality (D).The responsiveness of a firm towards the environment (D) is reflected by different environmental management practices ($SWMP_i$) adopted by the firm. These practices depend on the individual incentives faced by the decision maker/ management (I_{ji}), where *j* = types of incentives ($j = 1, 2, 3 \ldots m$) and the characteristics of the firm (F_{ki}), where *k* = sizeor type of the firm (*Caswell et al. 1998*; *Segerson 1999*).

Following *Nakamura et al.* (*2001*) from the maximization of the utility function, the following empirical expression of the determinants i^{th} firm's environmental management practices where ε_i is an error term is derived:

$$SWMP_i = \alpha_i + \beta_j I_{ji} + \gamma_k F_{ki} + \varepsilon_I \qquad (1)$$

An important issue is to identify incentives to represent market, regulatory and liability incentives that are likely to affect SWMP. It hypothesized that a firm's decisions to adopt SWMPs is likely to be positively associated with the firm's perception that: these practices will increase technological efficiency of day-to-day operations [TCE] (e.g. less by-products, introduction of new technology); adoption will contribute to more efficient labor and management of the firm [HRE] (e.g. staff morale, team work, well-defined work assignments); adoption will increase sales and revenue of firms [SLR] (e.g. through demand for quality products); there is commercial pressure from external forces [CPR] (e.g. customers, trade associations and neighborhood) for firms to behave in an environmentally responsible fashion; adoption will enhance the reputation of firm [REP] (e.g. promote brand capital, first-mover advantage and by avoiding chances for "name & shame"); liability laws/judiciary are important to the firm [LBL] (e.g. fines, compensation, legal costs); existing government regulation [EGR] (i.e. law enforcement, closure of firm) matter; stricter anticipated regulation on environmental management [AGR] (i.e. global standards, mandate) will motivate firms to act sooner than later, and negatively associated with expected direct costs [CST] (e.g. plant restructure, inputs) and other financial implications (e.g. budgetary allocations, access to credits and subsidies) associated with adoption of such practices (*Caswell et al. 1998*; *Segerson 1999*; *Khanna and Anton 2002*; *Jayasinghe-Mudalige and Henson 2006a*; *2006b*). The researchers can extend equation (1) expressed above to specify the following econometric model:

$$\begin{aligned} SWMP_i = {} & \sigma_0 + \beta_1 * CST_i + \beta_{2*} TCE_i + \beta_{3*} HRE_i + \\ & \beta_{4*} SLR_i + \beta_{5*} CPR_i + \beta_{6*} REP_i + \\ & \beta_{7*} EGR_i + \beta_{8*} AGR_i + \beta_{9*} LBL_i + \\ & \gamma_{1*} FT_i + \gamma_{2*} FS_i + \gamma_{3*} VT_i + \gamma_{4*} EX_i + \varepsilon_I \end{aligned} \qquad (2)$$

where: $SWMP_i$ denotes the dependent variable, i.e. the total number of solid waste management practices adopted. The right hand side variables include: σ_0 = intercept, β_j = coefficients of nine individual incentives ($j = 1, 2 \ldots 9$) considered in the analysis and γ_k = coefficients of characteristics of a firm (F_{ki}) denoted by dummy variables such that FT = firm type (based on the major products processing); FS = firm size (very large, large, medium, small, very small based on annual returns); VT = Vintage (1 = ≥10 years; 0 = <10 years), and EX = Export orientation (1 = export; 0 = do not export products).

The MENR has recommended eight such practices to firms: sorting of waste based on 3R (reduce, reuse and recycle) systems; composting; use of biogas technology; use of biodegradable packaging materials; development of sanitary land filling; good manufacturing practices; waste auditing and ISO 14000. To obtain a measure of 'intensity of adoption', we first assessed if any of the MENR strategies had been adopted by the firm by considering the number of SWMPs adopted (i.e., zero, one, or more). It does not suggest any recommended order in which to adopt these practices in the food sector. Further, none of these practices is endowed with a higher value over the others. Thus, some firms adopt no practices, others may adopt a single or a few (i.e., two or three) practices at a time, whereas still others may adopt all measures (i.e., seven or eight). As the dependent variable ranges from zero to eight and a number of zeroes could be obtained, it is appropriate to use Count Data Regression models for estimating equation (2) (*Chowdhury and Imran 2010*).

The incentives identified above are very critical to the

analyses but the literature suggests that it is not possible to include which directly in the econometric model as explanatory variables. This is because of three main reasons: Mutual Exclusivity and Endogeneity– some of these incentives are not mutually exclusive and are endogenous to the decision making process. Thus, they cannot be included as independent determinants of environmental compliance; Subjectivity– the incentives involve subjective assessments that need to be explored more fully to understand how management perceives the incentives in terms of potential benefits and costs to the firm; and Unobservability– researcher cannot directly observe the nature of incentives prevailing at the firm level (*Hair et al. 2006*; *Nakamura et al. 2001*).

In order to overcome these difficulties, Confirmatory Factor Analysis (CFA) technique was used, which is a part of Structural Equation Modeling (SEM) and is commonly described as the Measurement Model (MM) of SEM (*Hughes et al. 1986*; *Hair et al. 2006*) to develop estimable variables for individual incentives. This is a common practice when important variables or 'constructs' cannot be measured without error. Instead, 'indicators' that can represent these latent constructs were identified. For the purpose of this study, the nine individual incentives are latent construct variables and specified in a set of' attitudinal statements' reflecting observable characteristics of these incentives as indicators.

Once the indicators for the nine constructs were identified, each of these indicators or attitudinal statements was ranked by firms' decision-makers on a Likert-scale. With the help of AMOS and SPSS software we use the scores provided by respondents for each indicator to resolve the empirical problems of non-exclusivity, endogeneity, subjectivity and unobservability. Once valid and reliable indicators are identified through these tests, the scores given by respondents to these indicators on the multi-point Likert-scale are treated as objective measures of incentives.

Since there are several indicators for each incentive, an aggregate measure or value for each incentive were not determined. To obtain this, the scores given by respondents to each indicator i.e. attitudinal statement was used, to derive an index for the respective incentive (j = 1, 2…9). This is referred to as an Incentive Index (I_{ji}), determined by taking the aggregate of the scores given by a respondent to all indicators of an incentive on the 5-point Likert Scale and dividing it by the Maximum Potential Score:

$$I_{ji} = \text{Aggregate Score (AGS)/Maximum Potential Score (MPS)} \quad (4)$$

The MPS in equation 4 was used to normalize the value of the Incentive Index so that its value would range from -1 (minimum) to +1 (maximum). In effect, the magnitude of the Incentive Index obtained for each incentive for every firm signals the perceptions and the true behavior of the firm in question in relation to these individual incentives, and used it as a proxy to represent those incentives in the econometric model (*Henson and Traill 2000*).

Data Collection and Analysis

For data collection purposes, we categorized firms into five key sub-sectors based on the type of product: processed fruits and vegetables (PFV); coconut products (COP); essential oils (ESO); non-alcoholic beverages (NAB), and other processed products (OPP). The contact details of firms were obtained from the Municipal Council (for urban-based factories) and at Pradeshiya Sabha (for rural-based factories) levels on the recommendations given by the Department of Census & Statistics of Sri Lanka, the Ministry of Industrial Development; the Federation and Regional Chambers of Industry and Commerce, and the National Agribusiness Council of Sri Lanka etc.

The collection and analysis of data were done in two phases: the Pilot Study and the Main Survey. The purpose of the Pilot Study was to validate the preliminary questionnaire designed to obtain data on SWMPs and individual incentives facing firms. A series of in-depth face-to-face interviews were carried out using structured questionnaire with the top-most executives from 36 food processing firms from July to September 2008. These interviews were followed by an inspection of the site for cases where permission was granted. In the interviews, information about the respondent, the firm's characteristics and attitudes toward different practices were obtained.

The data on attitudinal questions require careful elaboration. The questionnaire included 81 attitudinal statements (i.e. 8 statements per incentive x 9 incentives + 9 validation items to represent 9 incentives). For example, an attitudinal statement such as "I am really concerned about the costs involved with restructuring this firm to accommodate those SWMPs" was used to assess attitude associated with incentive 1 (Cost/financial implications). Following good practice (*Henson and Traill 2001*; *Hair et al. 2006*), these 81 statements were written in such a manner that respondent firms would "agree" (disagree) with a statement, if the phenomenon underpinning it was perceived as a positive (negative) incentive for the firm to act (not to act) on environmental quality. For each such attitudinal statement, respondents were first asked to respond on a two-point Likert scale, i.e. (1) agree (yes), or (2) disagree (no). Respondents were then asked to rate the same statement on a five-point Likert-scale based on the extent to which he/she agrees or disagrees (*Oppenheim 1992*).

The data from 36 firms was subjected to CFA techniques to eliminate superfluous indicators to select the most valid and reliable statements to formulate the final questionnaire. A number of statistical tests specified under the CFA such as: Construct/Scale Reliability (with the Cronbach alpha); Unidimensionality (with the Principle Axis Factoring): and Construct Validity (with the Multi-Trait Multi-Method matrix) were applied individually using the SPSS[1].

The main survey was carried out from January to September 2009 and collected data from 325 firms. The questionnaire consists of 43 out of 81 statements and 9 validation items. The SEM in Analysis of Moment Structures (AMOS) version 16 was used to formulate the Measurement Model (**Figure 2**) and estimated using Maximum Likelihood Estimation (MLE) techniques to make sure whether the indicators chosen were adequate measures of the nine incentives.

The MM is significant at ρ=0.01 since the ratio of overall model X^2 to degrees of freedom (df), i.e. $X^2/df = 2.308$ is below the accepted cut-off value of <3.00.This proves the unidimensionality of the model (*Hair et al. 2006*). The resulting Standardized Factor Loadings (λ), which is given as "Regression Weights" in AMOS, can be used to evaluate liability and validity. *Hair et al.* (*2006*) recommended that λ should be 0.5 ideally 0.7 or higher. In this analysis, all loadings of the estimated model were significant with 31 out of 43 statements had λ above 0.7 and only 5 statements with λ below 0.5.

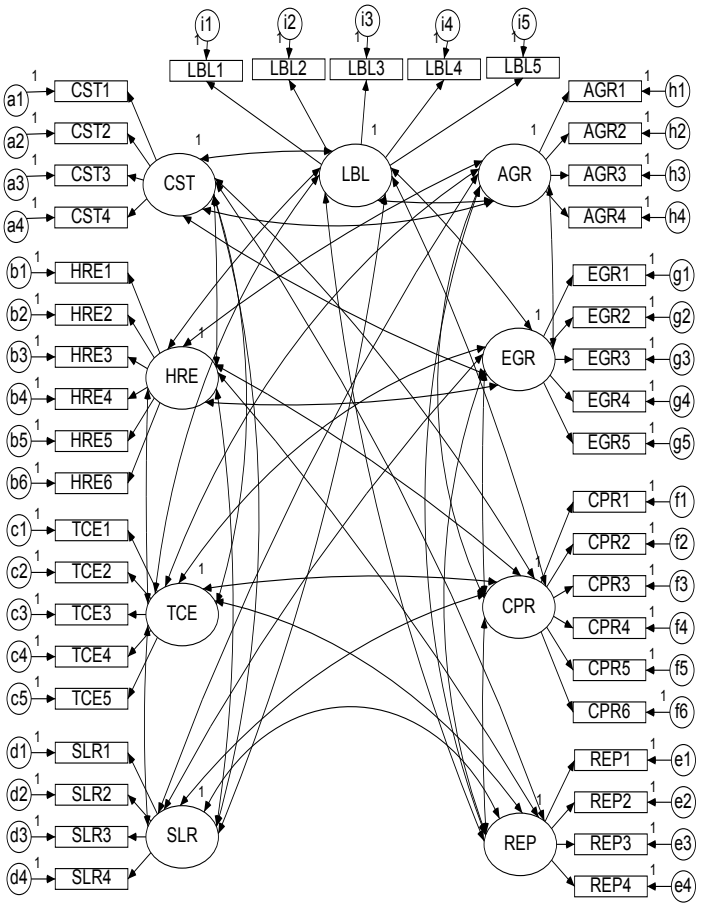

Figure 2. Measurement model in SEM derived through the AMOS

Once the model fit is established, the next step is to test for Construct Validity by evaluating the Convergent validity and Discriminant validity. To facilitate evaluating the former, two specific measures were estimated, namely Construct Reliabilities (CR) based on the formulae $(\Sigma\lambda_j)2/(\Sigma\lambda_j)2+\Sigma(1-\lambda_j2)$ and Average Variance Extracted (AVE) based on the formulae $\Sigma\lambda_i2/n$, where λ = Standardized Factor Loading and n = Number of Items (*Garver and Mentzer 1999*). The results from AMOS show that all CR, except two incentives (EGR and AGR), are above the ideal 0.7 cut-off. For AVE, a value of 0.5 or higher suggests adequate convergence while the scale has higher distinct validity (*Fornell and Larker 1981*).Only three incentives of the AVE (CPR, EGR and AGR) were below the 0.5 cut-off. This has resonance with the low Regression Weights obtained for indicators of these incentives (*Dunn et al. 1994*). The satisfaction of conditions for all the Regression Weights, CR, and AVE support the Convergent Validity of the MM to a reasonable extent, and this likewise proves scale reliability.

The recommended approach for establishing Discriminant Validity is to compare the Squared Correlation between two constructs with each of the individual AVE estimates. The AVE estimates should be greater than the squared correlation estimate.Twenty-seven out of the 36 inter-construct combinations satisfied the criterion and only nine inter-construct correlations (**Table 1)** (highlighted in yellow) exceed the AVEs of either of the Latent Constructs (*Hair et al. 2006*).

Table 1: Estimates of squared correlations to establish discriminant validity.

CST									
TCE	0.91								
HRE	0.81	0.81							
SLR	0.68	0.70	0.79						
CPR	0.77	0.94	0.75	0.70					
REP	0.84	0.81	0.74	0.61	0.73				
EGR	0.46	0.39	0.57	0.68	0.47	0.35			
AGR	0.43	0.34	0.42	0.45	0.36	0.35	0.45		
LBL	0.79	0.71	0.67	0.59	0.68	0.61	0.33	0.38	
	CST	**TCE**	**HRE**	**SLR**	**CPR**	**REP**	**EGR**	**AGR**	**LBL**
AVE	*0.87*	*0.86*	*0.66*	*0.63*	*0.82*	*0.46*	*0.31*	*0.33*	*0.57*

[1]Given the page limitations, the descriptive statistics pertaining to all statements and the specifications and results of these tests are not elaborated here and can be supplied to any interested reader upon request.

RESULTS AND DISCUSSION

Characteristics of Firms in the Sample

Data from 325 firms were categorized into five types on the basis of the produce: Coconut Products [COP] (9.5 %), Essential Oils [ESO] (18.2 %), Non-Alcoholic Beverages [NAB] (22.2 %), Other Processed Products [OPP] (21.5 5) and Processed Fruits and Vegetables [PFV] (28.1 %) (**Figure 3**).

Categories of firms along the value of annual sales are very small (25 %)(< Rs. 100,000), small (22 %)(Rs. 100,000 – 500,000), medium category (15 %)(Rs. 500,000 – 1,000,000), large category (17 %)(Rs. 1,000,000 – 5,000,000) and very large (21%)(> Rs. 5,000,000) (**Figure 4**). The majority of firms producing essential oils (64.4 %) and other processed products (67.1 %) were either small or very small. On the other hand, the firms engaged in producing coconut products (48.3 %) and non-alcoholic beverages (65.2 %) were either large or very large. It also shows that nearly 40 % of firms were involved in export markets. About 50.5 and 46.5 % of firms traded with wholesalers and direct customers.

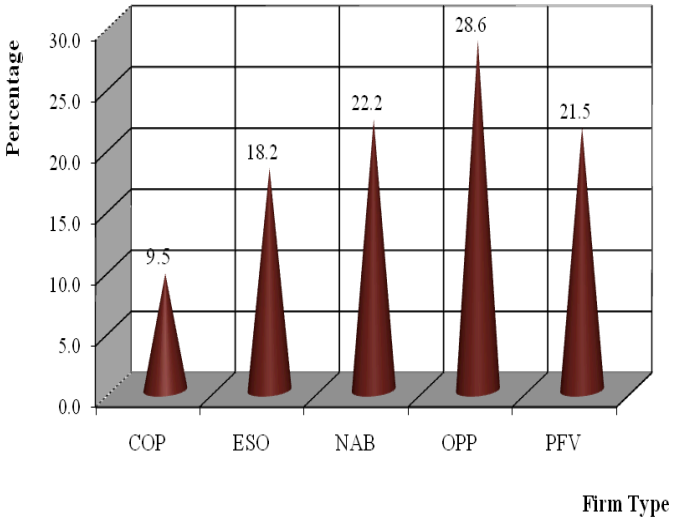

Figure 3. Percentage of firms by type.

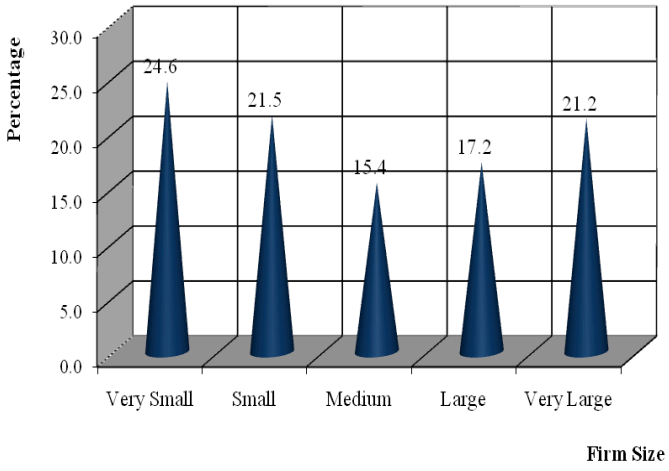

Figure 4. Percentage of firms by size.

Types of SWMPs Adopted by Firms and the Strength of Individual Incentives

"Composting" (31 %), "3R system" (24 %) and "Good Manufacturing Practices" (24 %) were the popular measures to control solid waste generated in the firm as compared to "Bio Gas Unit" (4 %) and "ISO 14000 series" (5 %) (**Figure 5**). About 47 % of the 325 firms did not adopt a single SWMP as suggested by the MENR. Another 26 % adopted only 1, 2 or 3 out of the 8 practices. Only 5 % of firms have more than 5 SWMPs in place. The number of SWMPs adopted by a firm varied to a great extent vis-à-vis the type of the firm and its size. Firms that produce non-alcoholic beverages and processed fruits and vegetables tend to adopt a higher number of SWMPs compared to firns producing oils and coconut products. In fact, nearly 75, 63 and 61 % of essential oil, other processed products and coconut product processing firms, respectively, did not adopt a single SWMP. With regard to firm size, large firms, expectedly, tend to adopt a higher number of SWMPs. For example, nearly 29 % of very large firms adopted more than 4 such practices in the firm compared to 71 % of very small firms who did not adopt a single practice.

For firms either without or with only one or two SWMPs, the value of the MII of most market-based incentives (e.g. CST, HRE, TCE, SLR, REP) is either negative or only slightly positive (e.g. CPR) (**Table 2**). Further, the values of the MII of regulatory and liability incentives are positive irrespective of the number of SWMPs in place (**Figure 6**). The magnitude of the Incentive Index, which ranges from -1 to +1 and reflects the relative strength of an incentive, is on average falls between -0.5 to 0.5. This indicates that on average firms do not consider incentives as very important in their decision to adopt SWMPs. Overall, the firms' average level of adoption of SWMPs is relatively low at given that the Ministry of Environment recommended about eight practices.

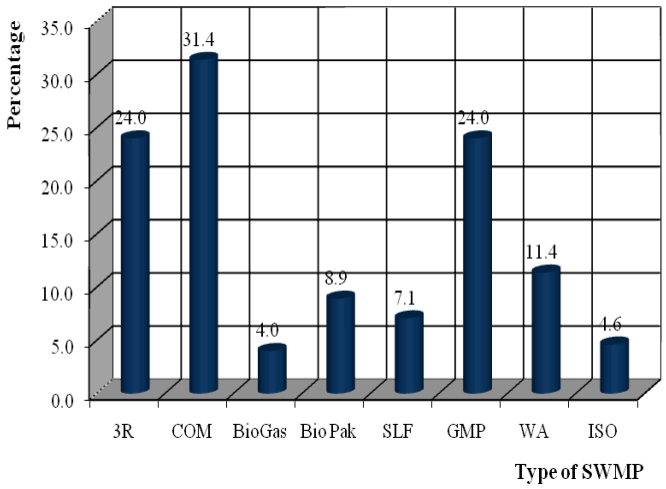

Figure 5. Different types of SWMPs adopted by firms.

Table 2. Mean values of the incentive index of variables.

	CST	TCE	HRE	SLR	CPR	REP	EGR	AGR	LBL
Total Sample	-0.74	-0.57	-0.25	-1.05	0.01	-0.78	0.72	0.85	0.50
Based on Type of the Firm									
COP	-0.20	-0.05	-0.26	-0.55	-0.47	0.08	0.47	0.55	0.37
ESO	-0.59	-0.35	-0.59	-0.69	-0.65	-0.20	0.32	0.41	0.10
NAB	-0.01	0.09	0.00	-0.52	-0.20	0.18	0.44	0.51	0.42
OPP	-0.63	-0.43	-0.67	-0.71	-0.67	-0.14	0.32	0.35	0.06
PFV	-0.36	-0.24	-0.40	-0.62	-0.48	-0.03	0.38	0.48	0.24
Based on Size of the Firm									
Very Small	-0.89	-0.70	-0.87	-0.85	-0.85	-0.30	0.19	0.25	-0.15
Small	-0.86	-0.55	-0.81	-0.78	-0.80	-0.28	0.28	0.40	-0.03
Medium	-0.44	-0.22	-0.57	-0.63	-0.58	-0.05	0.45	0.56	0.31
Large	0.12	0.11	-0.06	-0.55	-0.42	0.11	0.44	0.50	0.49
Very Large	0.38	0.45	0.45	-0.25	0.24	0.44	0.59	0.62	0.67

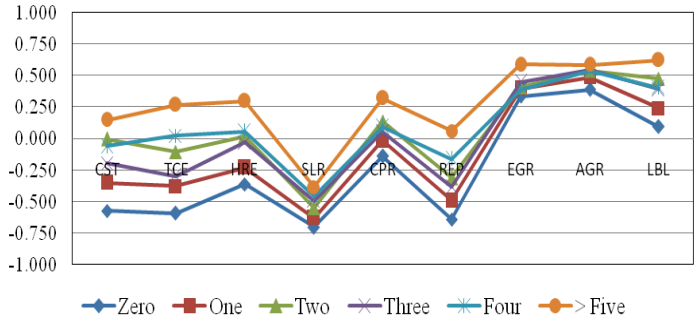

Figure 6. No. of SWMPs adopted by a firm and value of incentive index.

Outcome of the Count Data Model

The first step towards a Count Data Analysis was to examine the excess zeros and over-dispersion of the data. Data were distributed with a Mean (Standard Deviation) of 1.153 (± 1.559) (i.e. Variance = ± 2.430), showing that there is an over-dispersion. Therefore, a model other than the Poisson model in which the two are constrained to be equal was also considered. Also the histogram of the response variable obtained shows that the number of zeros is excessive (**Figure 7**). These findings suggest that it is best to estimate the econometric model with other options available, including Zero-Inflated Poisson (ZIP) and Zero-Inflated Negative Binomial (ZINB) models that could account for this over-dispersion (**Table 3**).

The Vuong statistic (V=3.36) compares the ZIP and PR models. Since it is significant, ZIP was preferred over the PR model. Where NBM is considered, the Vuong *t*-test (V=4.64) result further suggests that the ZINB outperforms its parent specification, which is the Negative Binomial model (NB). This test is also supported by the Likelihood Ratio (LR) test that was carried out to investigate whether or not the ZINB model reduces to the ZIP model. The LR test statistic favors the ZINB model over the ZIP model.

The coefficient of CST is negative for both ZIP and ZINB models and significant at 5 % implying that with every unit increase in the cost of adoption there is decrease in the adoption of recommended practices at the firm level (**Table 3**). However, as cost is a negative incentive, there is a need for firms to be financially supported to increase the potential of adoption. The TCE is statistically significant in both models, which implies that the perceived improvements in technical efficiency of the firms act as a positive incentive leading to a higher adoption rate. For most firms, especially for small and medium-scale firms, technical efficiency can

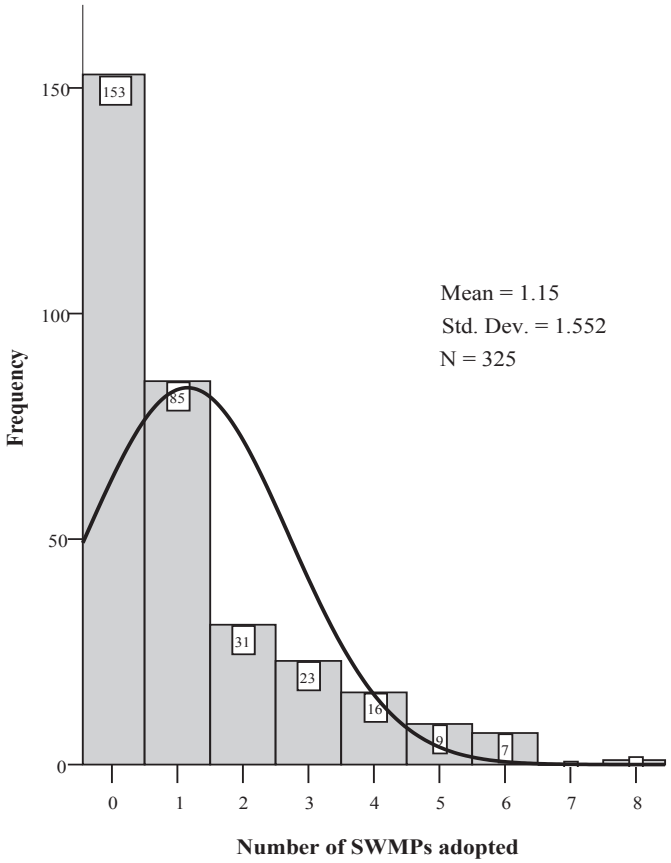

Figure 7. Total number of different SWMPs adopted by firms.

Table 3. Outcome of count data analysis.

Covariates	Zero Inflated Poison (ZIP)		Zero Inflated Negative Binomial (ZINB)	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**
Incentives				
CST	- 0.946**	0.003	- 0.785**	0.020
TCE	0.767**	0.035	0.678**	0.048
HRE	0.132	0.631	0.021	0.939
SLR	0.308	0.452	0.189	0.594
CPR	0.240*	0.240	0.165	0.618
REP	0.138	0.665	0.161	0.622
EGR	0.177	0.538	0.138	0.630
AGR	0.247**	0.022	0.133**	0.032
LBL	0 .081**	0.035	0.136**	0.048
Constant	-3.047	0.117	4.758	0.651
Sector Dummies				
ESO	0.961	0.095	0.540*	0.108
NAB	-0.459**	0.405	-0.097	0.717
OPP	-0.498	0.384	-0.162	0.623
PFV	-0.122	0.822	-0.235	0.380
Scale Dummies				
Very Large	1.108	0.056	0.839**	0.048
Large	1.056**	0.015	0.817**	0.015
Medium	0.889**	0.012	0.781**	0.010
Small	0.650**	0.028	0.600**	0.026
Vintage (VT)	0.926**	0.000	0.958**	0.000
Export (EX)	-0.080	0.543	0.075	0.580
Log likelihood	-375.196		-403.39	
LR chi2(18)	245.18**		2.09**	
No Obs				
No of Zero				
Inflation model	logit		logit	
Vuong test	3.36**		5. 65 **	
Likelihood Ratio Test			2.09**	

Note: Coe. = Coefficient; SE = Standard Error; Prob. = Probability *** Significant at prob. = 0.01; ** Significant at prob. = 0.05; * Significant at prob. 0.10

be a critical factor for implementating SWMPs as it has a direct impact on their production.

The coefficients of all other incentives including Human resource efficiency, Sales and revenue, Reputation and Commercial pressure (HRE, SLR, REP and CPR) are not statistically significant. Thus, firms do not see human resource changes or reputational issues as important reasons for adopting SWMPs. This is contrary to the outcomes reported in previous research on environment and food quality management in the context of developed and developing countries. Market-based incentives such as reputation, commercial pressure and increased human resource efficiency were expected to play a greater role when it comes to motivating firms to adopt environmental management measures. The regulatory incentive of existing government regulation (EGR) is not likewise found to statistically significant. It is possible that existing failures in government policy may lead firms towards non-compliance. It is also possible that firms simply do not have clear information on government policies. However, anticipated government regulations (AGR) do motivate firms to adopt SWMPs especially those expecting stricter regulation in the future. Firms also respond to legal liabilities. Higher possibility of adopting of environmental management practices could be expected when firms perceive that there is liability from non-compliance. Both models show that there is a significant positive impact from liability laws on firm behavior.

When different sectors are concerned, there were no sector wise (i.e. firm type) significant effects on the adoption decision. However, the scale of firm (i.e. firm size) has an impact. The ZINB model shows that, in relation to very small scale firms, all other firms showed higher affinity towards adoption of SWMPs. The very large firms display the highest adoption rate.The number of years a firm has been operating (Vintage) does have a significant impact on the adoption decision. This suggests that, as a firm establish themselves, the sense of responsibility towards

environmental quality increases. However whether the firm is a product exporting company or not does not have a significant impact on the adoption. This is because environmental standards, unlike food quality standards, do not critically affect exports.

CONCLUSIONS

The outcome of this study rejects the hypotheses that a firm's adoption decision is triggered by market-based incentives. The outcome suggests that firms in Sri Lanka, in general, do not take into account market incentives or disincentives in the form of reductions in volume of sales and profits, negative customer reactions, loss of reputation and inefficiencies associated with the management of physical and human resources, when adopting environmental measures. However, costs associated with adoption seem to be the only market based incentive that matters. Firms also adopt less in the current period in anticipation of future laws. However, stronger current legal liability associated with non-compliance seems to motivate adoption. Further, the outcome of the analysis presents that the relative strength of an individual incentive faced by a firm is not the same across all firms wherein larger and the older ones are more likely to adopt SWMPs.

As expected, larger firms tend to adopt more practices while smaller firms do not. In terms of the type of industry, firms that produced non-alcoholic beverages and processed fruits and vegetables tend to adopt a higher number of SWMPs in comparison with those that processed essential oils and coconut products. Export oriented firms did not do better compared to non-export firms in terms of adoption. This is because environmental standards seem to matter less than food safety standards in the export market.

The results on the role of regulatory incentives in influencing adoption of SWMPs are also mixed. Current regulations do not seem to motivate adoption. Thus, the current government information provision; monitoring and regulatory roles do not matter very much yet. Firms do tend to adopt practices when it is anticipated that there may be stricter regulations in the future. Thus, the idea of stricter regulations seems to matter but current regulations seem to be too weak to make a difference. However, legal liability does influence a higher degree of adoption.

It is imperative to design private and public sector initiatives to achieve a higher level of environmental quality at the firm level. However, such initiatives should factor in differing industry structures and sizes of firms. Larger and older firms adopt more environmentally-responsible practices. Thus, particularly in newer sectors, there may be a lag between policy declaration and actual adoption. Firms and the industry may need to reach a degree of maturity before becoming more environmentally-compliant. In Sri Lanka, regulations may need to be altered at the provincial government level to overcome current shortcomings in the regulatory system. It is also possible that the situation would improve if firms were more carefully consulted during the process of establishing regulations and setting standards. Industry and trade organizations could also be engaged more to help facilitate the process of adoption with government playing a more facilitative role in augmenting firm-level incentives.

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