Governing Environmental Behavior of Firms Through Market Forces and Regulation: Case of Solid Waste Management in Agri-Food Processing Sector in Sri Lanka

Udith K. Jayasinghe-Mudalige and Menuka Udugama

Dept. of Agribusiness Management
Faculty of Agriculture & Plantation Management
Wayamba University of Sri Lanka
Makandura, Gonawila (NWP), Sri Lanka, 60170
Tele: +94 77 362 8911; Fax: +94 31 229 9246; e-mail: udith@hotmail.com

ABSTRACT

The purpose of this study was to quantify the effect of "market" (i.e. cost/financial implications, human and technical efficiency, sales and revenue, reputation and commercial pressure) and "non-market" (i.e. existing and anticipated government regulation and liability laws) based incentives on firms' private actions towards environmental quality. The case of adoption of solid waste management practices (SWMPs) suggested by the Ministry of Environment and Natural Resources (MENR) of Sri Lanka (i.e. 3R system, Composting, Sanitary land filling, Biogas unit, Biodegradable packaging, Waste auditing, GMP, ISO 14000) by the food processing firms in Sri Lanka was considered in the empirical analysis.

Based on the principles of Structural Equation Modeling (SEM), a "measurement model" comprises of 9 individual incentives was developed using the "*Analysis of Moment Structures*" (AMOS) software [*version 16*]. An in-depth interview and a site inspection visit was carried out from January to September 2009 with the owner/top most manager of the firm (n = 325), which was supported by a structured questionnaire designed with a specific format and validated through a pilot survey (n = 36)] to collect data. The firms in the sample comprised of: (1) coconut products [COP] = 31 (9.5%); (2) essential oils [ESO] = 59 (18.2%); (3) non-alcoholic beverages [NAB] = 72 (22.2%); (4) other processed products [OPP] = 70 (21.5%), and (5) processed fruits and vegetables [PFV] = 93 (28.1%). The *Confirmatory Factor Analysis* (CFA) techniques explained in SEM [i.e. *Scale Reliability* (Cronbach alpha), *Unidimensionality* (Principal Axis Factoring) and *Construct Validity* (Multi-Trait Multi-Method matrix)] were employed to minimize the empirical issues pertaining to development of estimable variables for individual incentives, including (1) mutual exclusivity; (2) endogeneity; (3) subjectivity, and (4) unobservability. The value of "Incentive-Index" derived through the CFA, thus, reflects the relative strength of an individual incentive for a given firm (range from -1.00 to 1.00).

Out of 325 firms contacted, 153 firms (47.1%) did not adopt a single SWMP suggested by the MENR. Another 85 (26.2%), 31 (9.5%) and 23 (7.1%) firms have adopted a 1, 2 or 3 out of 8 practices, respectively and only 17 (5.3%) firms have adopted more than 5 SWMPs in the firm. Given this nature, we have resolved to employ the principles of Count Data Models to specify the econometric model, and to which the number of SWMPs adopted by a firm and the values of Incentive-Index were included as the dependent and explanatory variables, respectively.

The outcome of analysis highlights that market-based incentives can play a significant role to motivate firms towards adoption of a higher number of SWMPs in the firm, but the lack of

mechanism to augment such incentives at the firm level results low rates of adoption of such practices, especially in the small firms. Further, it suggests that non-market incentives such as existing and anticipated regulation and liability laws play a much prominent role in compared to the market-based incentives to motivate all types of firms in this respect. The outcome of analysis, in turn, highlights the importance of developing an incentive-based institutional framework with appropriate market-friendly ("carrots") and regulatory/legal ("sticks") policy instruments and is capable of injecting such into the process of quality assurance systems in the key and most sensitive business sectors like food processing.

Key Words: Adoption, Compliance, Economic incentives, Environmental quality management, Food processing sector, Regulation, Solid waste management

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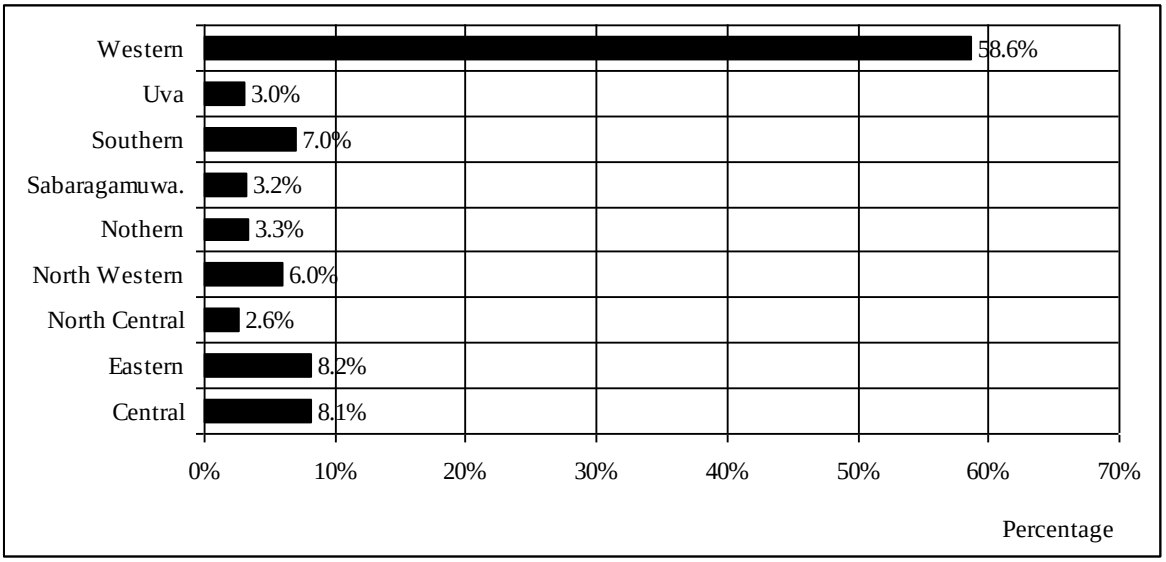
INTRODUCTION

The key result that emerges from the environmental economics literature is that "incentive-based policies" such as taxes and tradable permits are more efficient than "command and control" type regulations like 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 (Khanna, 2002; Segerson, 1999). In the context of environmental policy, however, it is difficult to formulate a set of appropriate policies that can be put into practice at the firm level, since we have limited knowledge of the level and nature of economic incentives available, in both a market and non-market context, for firms to comply with and/or adopt such controls at the firm level. The existing literature lacks empirical analyses and does not provide explicit directions, especially in the developing country perspective, on where the boundary should be drawn between the market and the government with respect to the role of a firm assuring a better environment for its stakeholders.

The *Database of Municipal Solid Waste in Sri Lanka* published by the Ministry of Environment and Natural Resources (MENR) in Sri Lanka shows that four out of the nine provinces of Sri Lanka (i.e., Western, Southern, Central and North-Western) are responsible for the generation of more than 80 percent of the solid waste at the municipal level by both households and industries (Figure 1) and most of which are generated from agricultural and food processing industries as "biodegradable" materials, for example, according to MENR, nearly 57 percent and 6 percent respectively of waste generated in the country are short-term and long-term bio-degradable materials (Figure 2).

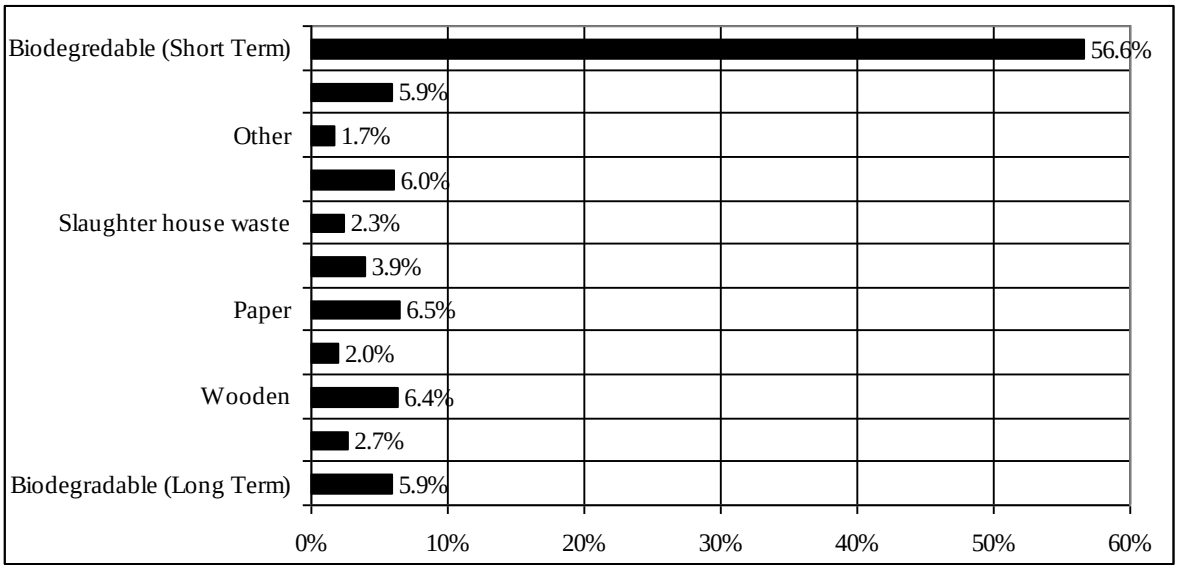
As a result, the problem of generation and accumulation of solid waste from households and various industries is being surfaced as a major issue concern amongst the stakeholders of environment and it is exacerbated by, amongst other reasons, the absence of a proper management system at the firm and household level and by the existence of a large number of food processing sectors that are both spread throughout the country at various scales. However, the recent analysis of data pertaining to waste accumulation from these industries reveals that the real problem is not the increased rate of generation of waste, but also the composition of waste and the haphazard disposal practices utilized by individual firms to get

rid of this waste. Despite all the formal regulations in place[1], many stakeholders in the food processing sector claim that the implementation and effective enforcement of formal regulations aiming the management of solid and liquid waste generated in this sector is very poor since regulations themselves vary significantly across local authorities as well as at the level of the provincial governments.



Source: Database of Municipal Solid Waste in Sri Lanka, MENR of Sri Lanka

Figure 1: Accumulation of solid waste in Sri Lanka



Source: Database of Municipal Solid Waste in Sri Lanka, MENR of Sri Lanka

Figure 2: Types of solid wastes accumulate in Sri Lanka

[1] The legal framework required for solid waste management (SWM) in Sri Lanka is provided under the Local Government Act. The local authorities are charged in terms of the act with the responsibility of collection and disposal of solid waste at the municipal, urban and *pradeshiya sabha* or local government level. Sections 129, 130 and 131 of the Municipal Council Ordinance, sections 118, 119 and 120 of the *Urban Council Ordinance*, and sections 93 and 94 of the *Pradeshiya Sabha Act* provide for the management and disposal of solid waste from the households and industries located in the respective areas.

The MENR has recently taken action to encourage firms to adopt effective and sustainable solid waste management practices (SWMP) through its "National Strategy for Solid Waste Management", which introduced a number of specific procedures that firms in the food processing sector should adopt in order to mange the solid waste generated in a firm. These include:

I. "*Sorting of waste based on 3R System*" – Establishment of necessary infrastructure facilities in appropriate places and allocating labor for the purpose.

II. "*Composting*" – The conversion of solid waste materials into composts, in which the heavy metal composition should be maintained below the recommended standards.

III. "*Biogas technology*" – Establishing units in accordance with the guidelines provided by the Ministry.

IV. "*Biodegradable packaging materials*" – Using material such as paper, glass, cloth, etc. instead of polyethylene and other non-biodegradable plastics. In case the use of plastic is unavoidable due to the nature of the industry, it must be degradable plastics.

V. "*Sanitary land filling*" – The maintenance of a site for which the firm should obtain clearance from the State after going through the Initial Environmental Examination (IEE) followed by Environmental Impact Assessment (EIA) based on guidelines provided by the Central Environmental Authority (CEA) in Sri Lanka.

Moreover, the Ministry encourages initiatives by individual firms to manage waste. Firms can obtain guidelines, proper training, and certification to adopt environmentally sound practices: (VI) a set of "Good Manufacturing Practices" (GMP); (VII) Regular "Waste Auditing" system; and (VIII) ISO 14000 Environmental Management System, etc. through the Sri Lanka Standards Institution (SLSI).

We may, however, consider that none of the practices mentioned above purely as "incentive-based policies" since they do not show off the characteristics of, or associated with, such instruments (e.g. taxes or penalties for non-compliance). Alternatively, they are teemed with the characteristics of "command and control" type technology standards. Nevertheless, the adoption of which at the level of firm is not mandatory, thus, an individual business can select either one or a combination of these practices or any other appropriate mechanism that they deem to be effective in rectifying the problems associated with the generation of waste in their premises.

Taking these facts into consideration, this study uses the data gathered from a cross section of food processing firms in Sri Lanka to examine specifically this economic problem of: what explains the differences that exist with respect to private action by individual firms on environmental quality or the interplant variations in responses towards the adoption of enhanced environmental management controls at the firm level? The specific objectives of the study are to: (i) identify the economic incentives for food processing firms in Sri Lanka to adopt various environmental controls aiming solid waste management (SWM) at the firm level; (ii) to quantify the extent to which those individual incentives motivate firm's behavior with respect to the selection of different types of controls to manage its solid waste; and (iii)

to assess the impact of firm and of market-specific characteristics of firms on the relative strength of an incentive that prevails at the firm level.

Literature on Incentives for Firms to Adopt Environmental Controls

The literature on this issue are broadly threefold, namely those showing: (a) the different types of government regulation affect the incentives for abatement and the associated costs; (b) that informal regulation by citizens and how information disclosure can lead firms to improve environmental performance, and (c) the voluntary adoption of environmental management systems such as ISO 14000 or less formally defined EMPs in developing countries. Yet, only a limited number of past studies have focused specifically on the issue of solid waste management on these lines and there is a paucity of literature on the subject in the context of Asian and, more specifically, South Asian countries.

The importance of plant characteristics, economic considerations and external pressure in determining the environmental performance of firms in Bangladesh, India, Indonesia and Thailand was explored by Hettige *et al.* (1996) using the evidence drawn from plant-level abatement practices. The outcome of which shows that pollution intensity is negatively associated with scale, productive efficiency and the use of new process technology while it is strongly and positively associated with public ownership. Amongst the external sources of pressure, the presence or absence of community action (informal regulation) emerges as a clear source of interplant difference. Based on an economic framework explaining the relationship between environmental demand and supply under informal regulation Pargal and Wheeler (1996) examined the impact of informal regulation on industrial pollution in the context of Indonesia using data from 243 firms from the different sectors. It shows that in the absence of without any formal regulations, equilibrium levels of emissions vary strongly across firms and regions in response to differences in scale, regional input prices, firm characteristics and the degree of informal regulation by local communities. According to this study, firm and plant characteristics appear to have an impact on pollution intensity. It shows firms in the food and paper sectors to have the highest pollution intensity.

According to Hartman, Huq and Wheeler (1997), despite weak or non-existent formal regulations as well as the failure to enforce environmental standards, many firms that operate in South and Southeast Asia are clean. To account for the extreme variation among firms, they reviewed the evidence from a survey of pollution abatement efforts by 26 pulp and paper plants in Bangladesh, India, Indonesia and Thailand using three sets of factors affecting pollution intensity. They were: (i) plant characteristics; (ii) economic considerations, and (iii) external pressure from the government and private stakeholders. The results suggest that the level of pollution abatement is positively associated with scale and competitiveness while it is negatively associated with public ownership and unaffected by foreign links (with regard to ownership or financing). Dasgupta *et al.* (2000) examine the effects of regulation, plant-level management policies and several other factors on the environmental compliance of Mexican manufacturers. They found that while many firms in Mexico avoid complying with regulations because of sporadic monitoring and enforcement, others over-comply with the regulations because their abatement decisions are strongly affected by extra legal factors. They capture both these possibilities in a model of decision-making under uncertainty, which shows that a firm minimizes expected pollution-related costs by setting emissions intensity (i.e., emissions/output) at the point where the marginal abatement cost (MAC) is equal to the expected marginal penalty (EMP) for polluting.

On the presumption that command and control environmental regulation has failed to achieve efficient solutions, Blackman and Harrington (1999) reviewed the prospects and consequences of using certain economic incentives in developing countries to combat air pollution. They discussed the advantages and disadvantages of using a number of instruments of economic incentives, including the emission fees, tradable permits and environmental taxes in Sweden, the United States, China, and Poland for this purpose, and asserted that both design deficiencies and pervasive constraints on monitoring and enforcement impede the effectiveness of such instruments in these countries. They it concludes that tradable permits are generally not practical while emission fee policies may probably be more appropriate.

In many developing countries, urban clusters of informal firms create severe pollution problems. Nevertheless, these firms are quite difficult to regulate for a variety of technical and political reasons. Blackman (2000) addresses this issue in great detail and develops a list of feasible environmental management policies. He then investigates how these policies have fared in four independent efforts to control emissions in the context of such firms (e.g., brick kilns) in northern Mexico. The outcome of the analysis suggests that, in general: (i) the conventional command and control process standards are generally only enforceable when buttressed by peer monitoring; (ii) clean technologies can be successfully diffused even when they raise variable costs, in part, because early adopters have an economic incentive to promote further adoption; (iii) boycotts of dirty goods sold in informal markets are unenforceable; (iv) well-organized informal firms can block implementation of costly abatement strategies such as relocation, and (e) private-sector-led initiatives may be the best suited for informal sector pollution control. Blackman and Bannister (1997) carried out an econometric analysis to determine the role of community pressure and clean technology among traditional brick makers in Mexico. According to the major findings of the study: (i) it is possible to successfully promote the adoption of a clean technology by intensely competitive informal firms even when the new technology significantly raises variable costs, and (ii) community pressure applied by competing firms and private-sector local organizations can generate incentives for adoption.

Because conventional command-and-control environmental regulation often performs poorly in developing countries, policymakers are increasingly experimenting with alternatives, including state-sponsored voluntary regulatory programs that provide incentives, but not mandates, for pollution control. Although the literature on this trend is quite thin, research in industrialized countries suggests that voluntary programs are sometimes ineffective because they mainly attract relatively clean participants seeking to free-ride on unrelated pollution control investments. Blackman *et al.* (2000) used plant-level data from more than 60,000 facilities to identify the drivers of participation in Mexico's Clean Industry Program. It suggests that the threat of regulatory sanctions drives participation in the program and the program did appear to attract relatively dirty firms. It also found that plants that sold their goods in overseas markets and to government suppliers, used imported inputs, were relatively large, and were in certain sectors and states were more likely to participate in the program, all other things equal. Powers *et al.* (2007) used a detailed plant-level survey data to evaluate the impact of India's Green Rating Project (GRP) on the environmental performance of the country's largest pulp and paper plants. It found that the GRP drove significant reductions in pollution loadings among dirty plants but not among cleaner ones. Further, it stated that the plants located in wealthier communities were more responsive to GRP ratings, as were single-plant firms.

Analysis of the count of environmental practices adopted by S & P 500 firms and based on Quantile Regression analyses. Anton *et al*., (2004) have shown that the increasing reliance of environmental policy on market-based incentives has led firms to shift from regulation-driven management approaches to proactive strategies involving the voluntary adoption of environmental management systems (EMSs). They concluded that liability threats and pressures from consumers, investors and the public are motivating EMS adoption and that consumer pressures are particularly effective in increasing the comprehensiveness of EMSs of firms that would otherwise be adopting a limited EMS. While regulatory and market-based pressures do not have a direct impact on toxic releases, they have an indirect effect through encouraging institutional changes in the management of environmental concerns.

Khanna *et al.* (2007) examines the motivations for firms to participate in voluntary environmental programs and to adopt environmental management practices using data gathered from a survey conducted in 2005 of facilities located in Oregon operating in six industrial sectors. It can be considered one of the first studies of voluntary environmental management to include small-, medium-, and large-sized facilities as well as to include both privately and publicly owned facilities. In particular, it examines the effects of both external factors such as regulatory, consumer, and investor pressures, and internal factors such as technical and resource capacity, in influencing voluntary environmental behavior. The intent is to describe potential influences that have implications for designing and implementing private and public policies that foster effective voluntary environmental management by firms. It found find that larger facilities were more likely to participate in more voluntary environmental programs, but were likely to adopt more EMPs only if environmental issues are of significant concern to them. Presence of an R&D department stimulates the adoption of more EMPs, particularly if environmental issues are of significant concern to the facility, but does not have a statistically significant impact on participation in voluntary programs. It also found that while regulatory pressures are significant in motivating participation in voluntary programs and adoption of EMPs, competitive pressures are only important in motivating the former. Pressure from final good consumers or from investors in publicly traded facilities was not found to have a significant influence on voluntary environmental behavior of facilities in this study.

Khanna and Anton (2002) used a behavioral model of firm decision-making to obtain econometrically testable hypotheses of the factors influencing firms to undertake proactive environmental management. These hypotheses are tested using survey data for a sample of S&P 500 firms. The analysis shows that economic factors such as the threat of environmental liabilities and high costs of compliance with anticipated regulations as well as market pressures on firms that produce final consumer goods and have large capital-output ratios play a statistically significant role in inducing corporate environmentalism among these firms. Additionally, high costs of off-site transfers of toxic releases and public pressures on firms with high on-site toxic emissions per unit output are significant in influencing the adoption of innovative environmental management practices. Rivera (2002) provides cross-sectional empirical evidence about the participation of hotels in the Costa Rican Certification for Sustainable Tourism (CST program), which is probably the first performance-based voluntary environmental program created by a developing country government. The outcome of analysis indicates that hotels with certified superior environmental performance show a positive relationship with differentiation advantages that yield price premiums. Participation in the CST program alone is not significantly related to higher prices and higher sales. The evidence also indicates that participation in the CST program was significantly related to

government monitoring, trade association membership and hotels focus on "green consumers".

Basing their study on the incentives given for chemical processing firms in the US to participate in the voluntary 33/50 program, Arora and Cason (1996) and Khanna and Damon (1998) investigated why some firms committed resources to achieving environmental performance beyond mere compliance with environmental regulations. They concluded that firms with more contact with final consumers and greater research and development expenditures were more likely to perform beyond the level of compliance. Nakamura *et al.* (2001) examined empirically the responses of managers towards environmental issues in Japan where they integrated the incentives for a firm to implement private and public regulatory environmental controls into a utility function. Arimura (2007), again in the context of Japan, estimated the effects of implementation of ISO 14001 and publication of environmental reports on the firms' environmental performance.

Henriques and Sadorsky (1996) tested the hypothesis that environmental regulations represent a main determinant of managerial action to deal with environmental concerns from the perspective of Canadian firms. According to them, government regulations are the single most importance source of pressure on firms to consider environmental issues. Klassen and McLaughlin (1996), on the other hand, found public announcement of environmental awards to have an immediate positive impact on the market valuation of firms for shares traded on the NYSE and AMEX. They also found significant negative impacts immediately following an environmental crisis associated with a specific firm. Garcia *et al.* (2004) evaluate the effectiveness of the Program for Pollution Control Evaluation and Rating (PROPER) in Indonesia. Using the panel data on changes in emissions concentrations for participating firms and a control group, the results show that there was indeed a positive response to PROPER, especially among firms with poor environmental compliance records. The response was immediate, and firms pursued further emissions reductions in the following months.

In addition to the above, a number of articles published related to this issue were of concerning the development of conceptual and theoretical frameworks. Segerson (1998), for example, developed a model to determine whether voluntary agreements could induce efficient environmental protection when the threat of mandatory regulation hovers in the background. Their study shows that the overall impact on environmental quality of such a threat could be positive or negative depending on a number of factors such as bargaining power, magnitude of the threat, and the social cost of funds. Weersink *et al.* (1998) examined the potential for applying economic instruments to regulate environmental problems in Canadian agriculture. According to them, the appropriate policy is one that minimizes the environmental costs of the residuals, the abatement costs to producers in reducing those levels, and the administrative costs to the regulator of monitoring and enforcing compliance. Rugman and Verbeke (1998a; 1998b) organized and integrated the literature on the impact of environmental regulations at the firm level from the viewpoint of managers making corporate strategy decisions. They developed an organizing framework, which consist of three related and sequential parts: (i) environmental regulations and corporate strategy, (ii) resource-based view of firm level green capabilities, and (iii) environmental regulations on a multinational enterprise strategy. Wu and Babcock (1999), Arora and Gangopadhyay (1995) and Stranlund (1995) have compared voluntary agreements between firms and the government with mandatory approaches to determine which was likely to be more efficient. Segerson (1986) suggests an incentive scheme with several potential advantages as a mean of inducing optimal abatement.

METHODS

Conceptual Framework

We can conceptualize that three main social processes, namely: (1) market; (2) political and (3) judicial can have important and distinct functions with respect to activities in the firm towards implementing environmental management controls (Figure 3).

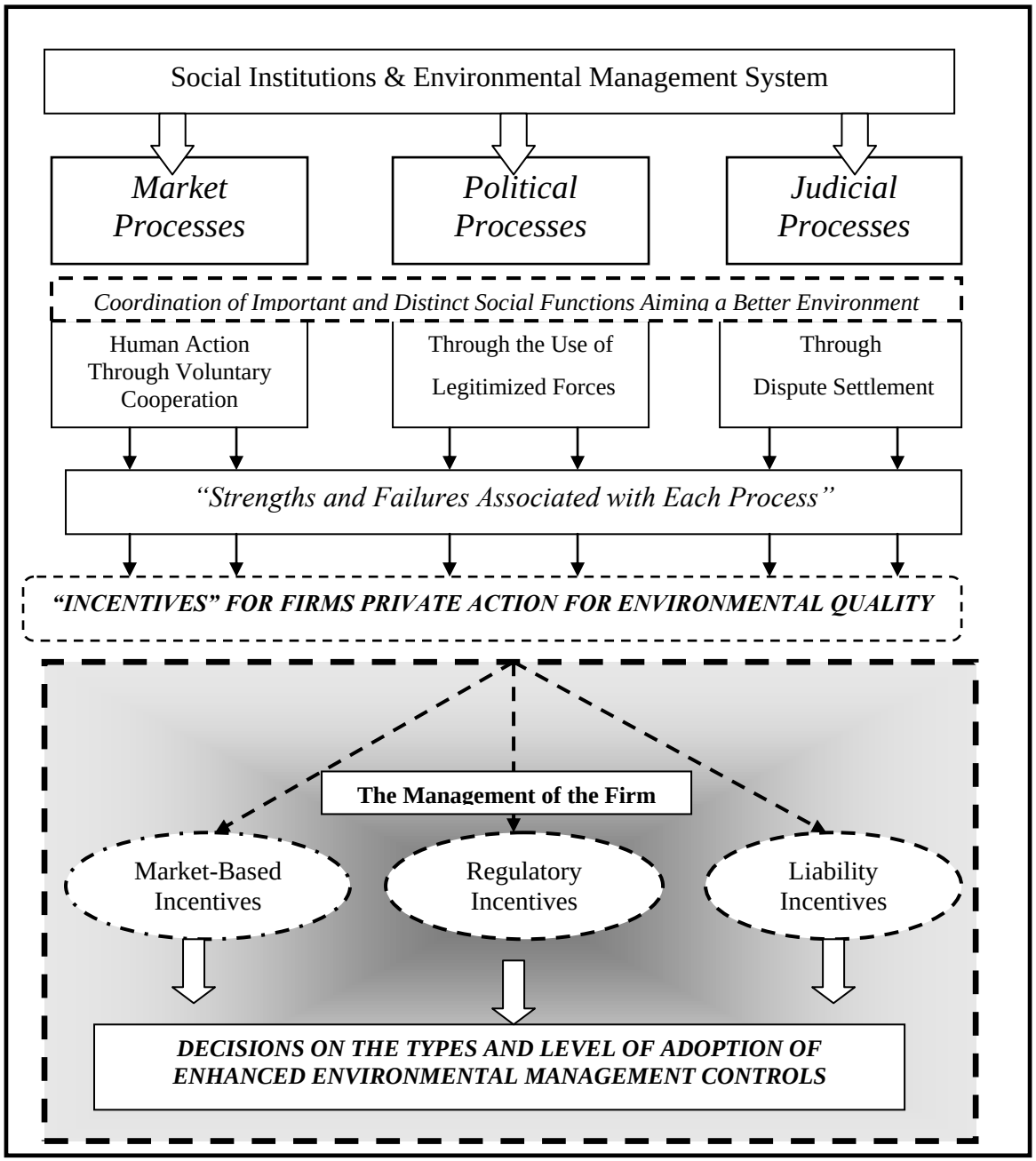


Figure 3 – Conceptual framework

The market processes may contribute in this respect by coordinating the human action of firms through voluntary cooperation. In the case of environmental quality, numerous types of environmental management controls, for example ISO 14000 series of standards and

enterprise-oriented and customer-specific practices, may be adopted by food processing firms voluntarily, or sometimes on the recommendation of trade and/or industry organizations that are working collectively for the betterment of the industry, i.e. 'quasi- voluntary' (Caswell *et al.*, 1998). The political process contributes by formulating and coordinating legitimized forces. In Sri Lanka, those public statutory and regulatory requirements of the National, Provincial and Municipal governments satisfy this requirement. Along with these, the judicial process contributes through dispute mediation, in which both the government and private institutions (non-governmental) play a substantial role. However, each of these institutions may also be subject to pathologies of their own in terms of market failure, policy failure, and failures in the judicial system. It is not possible for these social processes to work perfectly. Further, it would not be possible to recognize a system in which they did work perfectly.

However, lack of access to valid and reliable information is cited as one of the major obstacles that limit a comprehensive empirical analysis to assess a firm's responsiveness to environmental quality (Dasgupta *et al.*, 2000; Hettige *et al.*, 1996)[2]. While recognizing these difficulties, we have used the information included in the models presented by Caswell *et al.* (1998) and Segerson (1999) as well as certain agency models of the firm presented by Jenson and Meckling (1976) and Williamson (1986), with modifications, to derive the conceptual framework and, in turn, a set of hypotheses and the econometric model to examine this problem empirically.

Let us assume that the environmental policy of a firm that works to create a 'waste-free non-polluted environment' is characterized by the utility function $U_i = u\,[v\,(D_i \mid I_{ji}, F_{ki})]$ of the decision maker/management of the firm *i* (where $i = 1, 2, 3 \ldots n$) and u (v) is concave on its arguments. The management of the firm is responsible for complying with the regulatory requirements of the government. At the same time, the firm may decide to adopt various types of strategies voluntarily to manage the waste generated in the firm. Consequently, the term *v* in the above equation represents the overall gains to the firm through its responsible behavior towards the quality of environment where it operates[3]. We can, in turn, state that the degree of responsiveness of a firm towards the environment is reflected by the types of levels of environmental management controls and practices ($SWMP_i$) adopted by the firm *i*, which depend on the individual incentives faced by the decision maker/management in this respect (I_{ji}), where *j* = types of incentives ($j = 1, 2, 3 \ldots m$). The relative strength of an individual incentive (*j*) on this behavior possesses a relationship with characteristics of the firm (F_{ki}), where *k* = size and type of the firm, etc. Given the above notations, through the maximization of the utility function (see, Nakamura *et al.*, 2001), we derive the following regression form of an expression for an empirical analysis (where ε_i is an error term):

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

Hypotheses

Based on the conceptual framework presented above and findings from past studies, we formulated the following hypotheses for statistical testing, which takes into account the

[2] Exceptions apply, see for example Anton *et al.* (2004), Khanna and Anton (2002), and Henriques and Sadorsky (1996), who used direct and quantitative variables to estimate variables to represent individual incentives for the US and Canadian firms they studied using secondary data from well-managed databases from third parties (i.e., government, non-governmental groups and trade organizations).

[3] According to Nakamura *et al. (*2001), this is the 'intrinsic value' the manager derives as she tries to maximize her efforts to behave in a more environmentally friendly manner.

possible relationship between the types and levels of SWMP adopted by a food processing firm with different characteristics and the economic incentives that the decision maker/s of the firm possesses to act in this respect:

- *Hypothesis I* – A firm's decision to adopt enhanced SWMP has a significant relationship with the perceptions of its management towards 'potential losses' to the firm resulting from its 'failure in the market' which are greater than 'potential gains' to the firm resulting from 'failures in the government policy'.

  Here the firms' failure in the market would be characterized by, among the others, reduction in the volume of sales and profits; negative customer reactions; loss of reputation, and inefficiencies associated with the management of physical and human resources, etc. On the contrary, the failures in government policy would be in the form/s of inefficient tax regimes; lack of monitoring and enforcement through fines and giving compensations to the parties affected, and outdated policy instruments, etc.

- *Hypothesis II* - the relative strength of an individual incentive faced by a firm is, however, not the same across all firms and is associated significantly with the characteristics of the firm and the regulatory regime.

  The individual incentives a firm faces would be in the form/s of market-based, regulatory and liability incentives. The key firm-specific characteristics considered in the analysis would include the size and type of the firm, its customers and vintage.

Econometric Specification of the Model

We can extend equation (1) expressed above to specify the following econometric model:

$$SWMP_i = \sigma_0 + \beta_1 * CST_i + \beta_2 * TCE_i + \beta_3 * HRE_i + \beta_4 * SLR_i + \beta_5 * CPR_i + \beta_6 * REP_i + \beta_7 * EGR_i + \beta_8 * AGR_i + \beta_9 * LBL_i + \gamma_1 * FT_i + \gamma_2 * FS_i + \gamma_3 * VT_i + \gamma_4 * EX_i + \varepsilon_I \qquad (2)$$

where: $SWMP_i$ denotes the dependent variable (i.e., solid waste management practices adopted by a firm). The right hand side variables include: σ_0 = intercept, β_j = coefficients of 9 individual incentives (j = 1, 2…9) considered in the analysis, including: including "market-based incentives" such as (1) cost/financial implications (CST), (2) technical efficiency (TCE), (3) human resource efficiency (HRE), (4) sales & revenue (SLR), (5) commercial pressure (CPR) and (6) reputation (REP); "regulatory incentives" such as (7) existing government regulation (EGR) and (8) anticipated government regulations (AGR) and the "liability incentive", that is, (9) liability laws (LBL) (Jayasinghe-Mudalige and Henson, 2006a; 2006b), and γ_k = coefficients of characteristics of a firm (F_{ki}) such that *FT* = firm type; *FS* = firm size (based on annual returns); *VT* = vintage, and *EX* = export orientation (Caswell *et al*., 1998; Khanna and Anton, 2002; Segerson, 1999).

Specification of Environmental Controls as the Dependent Variable ($SWMP_i$)

The MENR does not suggest any recommended order in which to adopt these practices in a food processing firm. Further, none of these practices is endowed with a higher value over the others. In other words, each practice has its own merits. For the purpose of this analysis, we have presumed that the number of SWMPs adopted by a firm reflects its degree of

responsiveness towards environmental quality. Under these circumstances, there is a possibility that certain firms may decide to adopt a single or a few (i.e., two or three) practices at a time, whereas others may even go beyond (i.e., four or five) depending on the gains to the firm by doing so. On the other hand, there may be firms that do not adopt a single practice out of the list given above. In such case, an analyst may come up with a series of zeros as she works on a scale of: *Adoption* = 1; *Non-adoption* = 0 to report the status of adoption of these practices in the firm on an individual basis. At times, she may therefore experience excess zeros. In light of this, we use the total number of technologies/practices adopted by a firm as a measure of its 'intensity of adoption', which has been a common practice in literature on economics, where Count Data Regression models were employed for estimation purposes (Chowdhury and Imran, 2010).

We have, therefore, resolved to employ the principles of Count Data Regression models to estimate the coefficients of the econometric model specified above, which uses the number of SWMPs adopted by a firm as the estimable dependent variable ($SWMP_i$). First, we considered the adoption of any strategy out of an assortment proposed by the MENR (i.e., I to VIII explained above) by a food processing firm on an individual basis. After a thorough review of a firm's action towards implementation of any of these practices, we classified a firm as either an Adopter (Yes = 1) or as Non-adopter (No = 0) for a given practice. Then we took the number of SWMPs adopted (i.e., zero, one, or more) by a firm into account in specifying the Count Data Regression models.

Specification of Individual Incentives as the Explanatory Variables (I_{ji})

It is, however, unable to include the 9 individual incentives (j = 1 to 9) listed above directly into the econometric model specified as its explanatory variables. The reasons for this were:

(a) Mutual Exclusivity and Endogeneity – the prevalence of an individual incentive as an element of the system (Nakamura *et al.*, 2001; Shavell, 1987);

(b) Subjectivity – the management of the firm perceives these incentives in terms of potential benefits and costs to the firm (Buchanan, 1969); and

(c) Unobservability – the management cannot directly observe the nature of the incentives prevailing at the firm level (Hair *et al*., 2006).

In order to overcome these difficulties, we have decided to use the Confirmatory Factor Analysis (CFA) techniques [i.e., a multivariate data analysis technique that comes under Structural Equation Modeling (SEM)] to develop estimable variables for the 9 individual incentives (j = 1, 2…9).

SEM is a family of statistical models that seeks to explain the relationships among multiple variables and combines features of two models: (i) measurement model [Confirmatory Factor Analysis[4] (CFA)], and (ii) Structural Model into a simultaneous statistical test (Hair *et al*., 2006; Hughes *et al*., 1986). The CFA part of a SEM – commonly described as the measurement model[5] (MM) – in this study is used essentially to develop estimable variables

[4] The CFA helped the analysts to hypothesize the behavior of a firm in terms of these incentives and, in turn, to determine whether the observed data on each incentive confirmed the hypothesized behavior.

for individual incentives, which specifies a series of relationships that suggests how 'measured variables' represent a Latent Construct[6]. The measured variables of a Construct included in the MM are commonly referred to as Indicators[7] in the literature that reflects exactly the observable characteristics of the firm with respect to the Construct that underlines it. The nine individual incentives are such latent variables and are defined as Latent Constructs of the MM. In turn, we specify a set of 'attitudinal statements' reflecting observable characteristics of these incentives as the Indicators of the model[8] (see below).

Using the standard notations (Jöreskog & Sörbom, 1996; Hair *et al*., 2006), we can represent any single Indicator associated with an exogenous Latent Construct in the MM thus as a series of equations in the form of:

$$x_1 = \lambda_{x1,1}\, \xi_1 + \delta_1 \qquad (3)$$

where, $\lambda_{x1,1}$ represents the relationship between the latent factor ξ_1 and the measured variable, x_1, that it explains. But since it does not explain this relationship perfectly, δ_1 represents the error. Once we have identified the Constructs and their corresponding Indicators, we can use the Analysis of Moment Structures (AMOS) [version 16] statistical software to construct the MM as shown in Figure 4.

We use the scores provided by respondents to each Indicator on the multi-point likert-scale with the AMOS and the Statistical Package for Social Sciences (SPSS) [version 14] to get rid of the empirical issues cited above (i.e., non-exclusivity, endogeneity, subjectivity, unobservability, etc.) by applying a number of statistical tests specified under the CFA such as:

- *Construct/Scale Reliability* – This measures whether a set of Indicators representing a Construct are consistent in their measurement based on the formulae $(\Sigma\lambda)^2 / (\Sigma\lambda)^2 + \Sigma(1-\lambda_j^2)$. It is customary to use the Cronbach's alpha (α) (Cronbach, 1951) for this purpose. Since the aim of the test is to maximize α, researchers generally accept

[5] MM is a sub-model in SEM that: (i) specifies the Indicators for each Construct, and (ii) assesses the reliability of each Construct for estimating the causal relationships. It is similar in form to factor analysis; however, the major difference lies in the degree of control provided the researcher. In the MM the researcher specifies which variables are Indicators of each Construct, with variables having no loadings other than those on its specified Construct. However, in factor analysis, the researcher can specify only the number of factors although all variables have loadings for each factor.

[6] Constructs (latent variables) are concepts that the researcher can define in conceptual terms but cannot be directly measured (for e.g., the respondent cannot articulate a single response that will totally and perfectly provide a measure of the concept), or measured without error. Constructs are the basis for forming causal relationships, as they are the 'purest' possible representation of a concept. A construct can be defined in varying degrees of specificity ranging from quite narrow concepts (for e.g., household income) to more complex or abstract concepts (intelligence or emotions). Yet no matter what its level of specificity is, a Construct cannot be measured directly and perfectly, but must be approximately measured by items/Indicators.

[7] Indicators are 'observed values' that is used as a measure of the concept or Construct that cannot be measured directly. The researcher must specify which Indicators are associated with each Construct.

[8] Customarily, researchers use firsthand information gathered from participants to the study (e.g., owners/managers of food processing firms in this particular case) in order to develop the attitudinal statements (i.e., Indicators of the Constructs).

values above 0.7 as demonstrating that a scale is internally consistent[9] (Lord and Novick, 1968; Nunnally, 1978).

- *Unidimensionality* – This is evaluated by examining the loading of Indicators on to factors with a view to determining whether one broad or several specific constructs characterize the set of Indicators. It is common to use the Principal Axis Factoring Technique to examine this effect (De Vellis, 1991). While there is no rigorous criterion specified in this technique that can be applied to assess when factor loadings are significant, Spector (1992) suggests that a minimum value of around 0.30 to 0.35 indicates that an Indicator loads onto a factor.

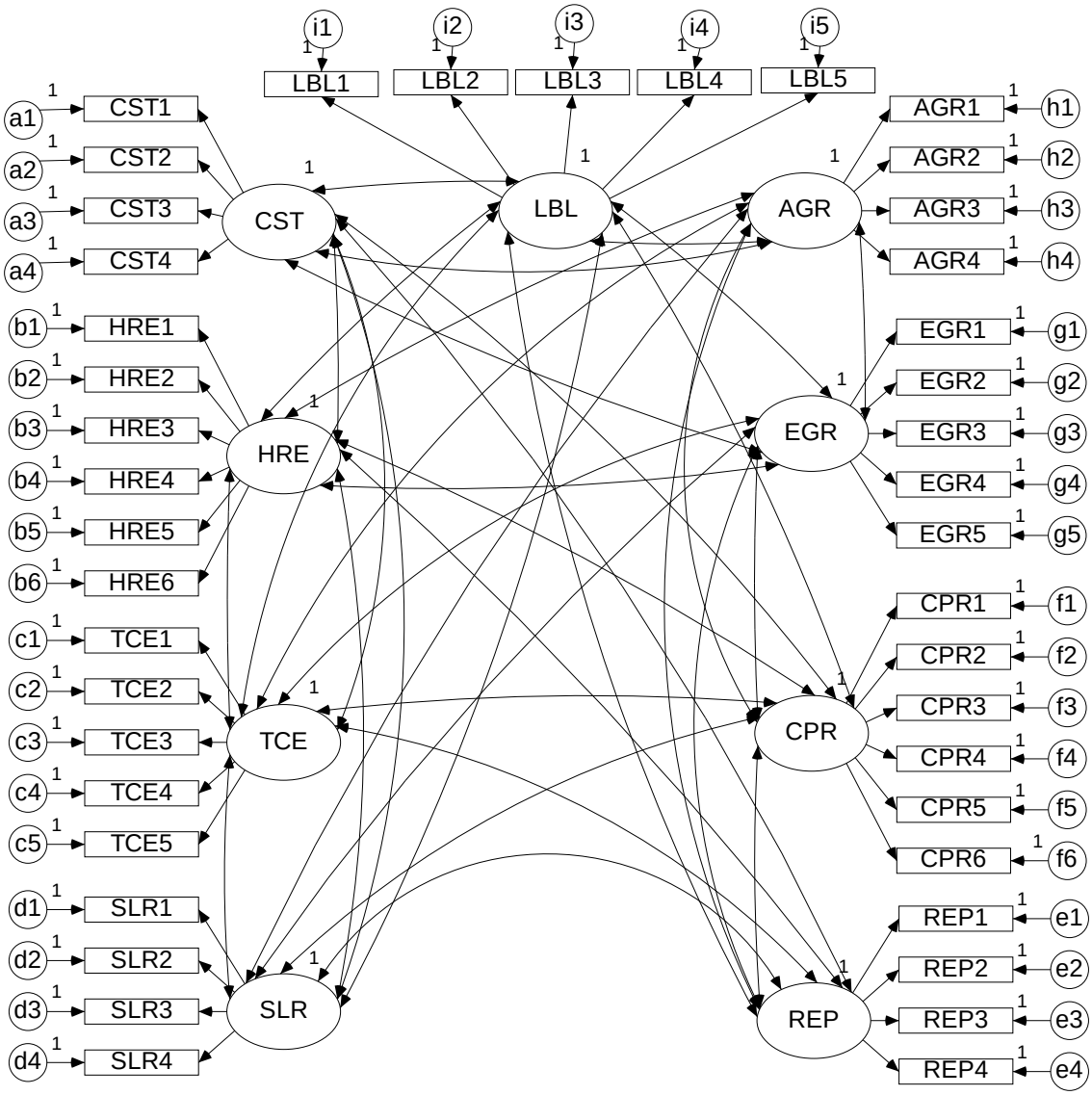


Figure 4: Measurement Model in SEM (Using AMOS)

[9] It is difficult to justify a proposed Indicator of a Construct in exploratory research if its reliability were less than 0.5, because in that case more than 50 percent of its variance would be an error variance.

- *Construct Validity* – This means the ability of Indicators of a Construct to accurately measure the concept under study[10] (De Vellis, 1991). Researchers assess this in terms of Face Validity (that is, content and meaning of the attitudinal statements in relation to their associated incentives), Convergent Validity (that is, indicators of a specific incentive should converge or share a high proportion of variance in common), Discriminant Validity (that is, the extent to which an incentive is truly distinct from other incentives) and Nomological Validity (that is, whether the correlations among the incentives in the measurement theory makes sense). Face validity can be established early, i.e., during the development of the questionnaire and scales for assessment. Researchers frequently use the Multi-Trait Multi-Method matrix (MTMM matrix), introduced by Campbell and Fiske (1959), to assess Construct Validity, which reports the correlation between different Constructs used in the analysis and an alternative measure used to evaluate the same phenomenon (e.g., Validation Items)[11] (Henson and Traill, 2000). Given two or more Constructs and two or more ways of measuring each, we can expect a high correlation between these two different measures[12] when they are used to evaluate the same Construct, but a low correlation between these measures when used for different Constructs, or in statistical terms this satisfies the condition of Convergent Validity [13] and Discriminant Validity [14] (Campbell and Fiske, 1959).

The outcome of CFA obtained through AMOS and SPSS can be used to determine whether the Indicators of Constructs included in the MM originally are statistically valid and reliable to derive an estimable variable for the corresponding incentive. If not, we need to purify the MM used in AMOS by removing those invalid and unreliable Indicators from respective Constructs and reiterate the above statistical tests on remaining Indicators until the conditions given under each test is satisfied. Once the valid and reliable Indicators of each Construct is selected through this process, we may regard the scores given by respondents to these indicators on the multi-point likert-scale as objective measurements or, in other words, free from those empirical issues listed elsewhere, and proceed with further analysis.

The scores given by respondents [i.e., every firm included in the sample (i = 1, 2…n)] to the Indicators of a Construct (i.e., attitudinal statements of an individual incentive) is next used in order to derive an index for the respective incentive (j = 1, 2…9) – referred to here as

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[10] It concerns the theoretical relationship of a variable to other variables, and it is the extent to which a measure behaves in the way the Construct it is hypothesized to measure should behave with respect to established measures of other Constructs.

[11] Following the standard guidelines for constructing a validation item for the CFA, we included 9 validation items in the questionnaire to represent corresponding individual incentives (constructs).

[12] The two different measures we use in this analysis to develop the MTMM matrix include: (i) value of the incentive related index [see the text], and (2) validation items.

[13] *Convergent Validity* – the indicators of a specific incentive should converge or share a high proportion of variance in common. We can estimate this by taking: (i) Factor Loadings (AMOS gives factor loadings as 'regression weights'), and (ii) Variance Extracted (VE) - a summary indicator of convergence in the form of $VE = \Sigma\lambda^2 / [\Sigma\lambda^2 + \Sigma(1-\lambda_j^2)$.

[14] *Discriminant Validity* – it assesses the extent to which an incentive is truly distinct from other incentives and the VE percentages for any two constructs is compared with the square of the correlation estimate between these two constructs.

Incentive Index (I_{ji}) – by taking the aggregate of the scores given by a respondent to all Indicators of an incentive on the 5-point Likert Scale (AIS) and dividing it by the Maximum Potential Score (MPS) that can be obtained by the respective incentive as shown in Equation 4 below:

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

We use MPS in equation (4) to normalize the value of the Incentive Index so that its value ranges 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 we can use it as a proxy to represent those incentives in the econometric model (Henson and Traill, 2000).

Survey Design and the Data

The food and food processing industries of Sri Lanka is categorized into 18 sub-categories by the Ministry of Industrial Development[15]. According to the Department of Census & Statistics – Industrial Survey (2003/2004), there were 36,939 firms belonging to these 18 sub-sectors in 9 provinces in Sri Lanka. We have resolved to select the food processing firms belonging to five key sub-sectors based on the type of product: (1) processed fruits and vegetables (PFV)]; (2) coconut products (COP); (3) essential oils (ESO); (4) non-alcoholic beverages (NAB), and (5) other processed products (OPP), located in four provinces [i.e., Western (WP), North Western (NW), Central (CP) and Southern (SP)] for the collection of data[16]. The population density of certain districts in these provinces (that is, Colombo, Gampaha and Kalutara in the Western Province; Kurunegala in the North-Western Province; Galle and Matara in the Southern Province and Kandy in the Central Province) is above 500 people per square km, which aggravates the problem of solid waste accumulation. Further, these four provinces are responsible for 5,839 (15.8%), 7,870 (21.2%), 4,606 (12.5%) and 4,717 12.8%) out of 36,939 food processing firms, respectively.

The contact details of firms that are engaged in the production of various types of food products at various scales were available at the Municipal Council (for urban-based factories) and at p*radeshiya sabha* (for rural-based factories) levels. For the purposes of preparing the sampling framework, we obtained the mailing lists of food processors that operate at various locations by contacting reputed institutions such as: (a) the Department of Census & Statistics of Sri Lanka; (b) the main and regional offices of the Export Development Board of Sri Lanka; (c) the Ministry of Industrial Development; (d) the Federation and Regional Chambers of Industry and Commerce; (e) National Agribusiness Council of Sri Lanka; (f) Coconut Research Institute of Sri Lanka; (g) Fruit and Vegetable Processors Association of Sri Lanka, and (h) Sri Lanka Standards Institution.

[15] These include: (1) food ingredients; (2) fresh fruits and vegetables; (3) poultry/meat; (4) processed meat and fish; (5) dairy products; (6) ethnic foods; (7) biscuit and confectionary; (8) bakery and flour-based products; (9) non-alcoholic beverages; (10) delicatessen products; (11) coconut products; (12) health foods and beverages; (13) frozen foods; (14) canned products; (15) preserved foods (16) essential oils; (17) herbal and organic products, and (18) convenience foods.

[16] More than 95 percent of firms in other sub-sectors were very small in nature with less than 5 employees, and was reported using traditional methods to manage waste generate and accumulate at the site (e.g. burning, put into Municipal waste baskets).

Data Collection and Analysis

The collection and analysis of data was carried out in two phases, namely: (i) the Pilot Study, and (ii) the Main Survey. The purpose of and activities in each phase is explained, in turn, briefly.

Pilot Study – Data Collection & Analysis

The purpose of the Pilot Study was to validate the preliminary questionnaire, which we had designed with a specific format in order to collect information from the respondents to develop estimable dependent variables for SWMPs and explanatory variables for the individual incentives (through the CFA) in a straightforward fashion. The questionnaire comprised 81 attitudinal statements (i.e., 8 statements per incentive x 9 incentives + 9 validation items to represent 9 incentives).

A series of in-depth face-to-face interviews supported by the structured questionnaire were carried out with the top-most executives from 36 food processing firms belonging to the 5 sub-sectors listed above in order to collect data from July to September 2008. The interview was followed by an inspection of the site for cases where permission was granted. We asked each respondent first to rate his/her perception about the observable characteristic explained in each statement (i.e., Indicator) with respect to the current performance of his/her firm on a two-point Likert scale, i.e., (1) *agree* ("yes"), or (2) disagree ("no") having instructed the respondent to rate the same statement on a five-point Likert-scale by taking into account of the extent to which he/she agrees (if they say "yes" in the 1st rating) or disagrees (if they say "no" in the 1st rating) with this particular statement (Oppenheim, 1992).

Following the good practices cited in literature with regard to setting a set of Indicators of a Construct in a Measurement Model (Hair *et* al., 2006; Henson and Traill, 2000), these 81 statements were written in such a manner that a firm would "agree" ("disagree") with a statement [i.e., "Yes ("No")], in general, if the phenomenon underpinning it was forced and/or was perceived as a "positive" ("negative") incentive for that particular firm to "act" (or "not to act") on environmental quality. We subjected the data from the 36 firms next to CFA techniques described above to eliminate superfluous Indicators and to select the most valid and reliable statements for the final questionnaire. Before commencing the CFA, we re-inverted the scores given to certain statements that were inverted purposely in the questionnaire. First, we carried out the Scale Reliability Test using the SPSS (Version 14). The analysis followed several rounds, and based on the values of Cronbach Alpha obtained, we excluded a number of statements from each incentive at the end of each round until we obtained its best value (Table 1). Except for 3 incentives (i.e., TCE, SLR and LBL), the value of Cronbach Alpha was greater than the commonly accepted level of 0.7. Nevertheless, we did not remove the remaining statements of these 3 incentives from the questionnaire as a slight deviation from the accepted value of 0.7 was possible due to specific reasons cited in the CFA literature (Hair *et al*., 2006).

The performance of the Principle Axis Factoring on the scales for nine incentives next indicated a high level of Unidimensionality, with all statements except two that have loadings exceeding 0.35. Indeed, most statements had loadings exceeding 0.60 while no statements had factor loadings less than 0.30. Therefore, none of the statements subjected to this test, which had already passed the Scale Reliability testing, was removed. At the end of these tests, we used the scores given by respondents to 43 out of 81 statements selected in order to derive

the Incentive Index (I_{ji}) of corresponding incentives based on equation (4) using the Multi-Item Summated Scale (MISS) techniques[17].

Table 1: Summary of Statistics from CFA

Incentive (Construct)	PILOT SURVEY				MAIN SURVEY	
	No. of Indicators Used	Excluded After CFA	Selected for Main Survey	Value of Cronbach Alpha	AVE	CR
CST	9	5	4	0.905	0.8716	0.9643
HRE	9	3	6	0.907	0.6641	0.9220
TCE	9	4	5	0.677	0.8586	0.9680
SLR	9	5	4	0.605	0.4609	0.8338
REP	9	5	4	0.823	0.8232	0.9489
CPR	9	3	6	0.896	0.6256	0.8696
EGR	9	4	5	0.925	0.3112	0.6480
AGR	9	5	4	0.778	0.3299	0.6259
LBL	9	4	5	0.640	0.5680	0.8590
Total	**81**	**38**	**43**			

Source: Pilot survey data (n = 36)
Note: AVE – Average Variance Extracted; CR – Construct Reliabilities

Finally, we used the values of the Incentive Index derived for each incentive to derive the MTMM matrix, which represents the correlation between: (i) the value of the Incentive Index derived for each incentive, and (ii) the value of the corresponding single-item Validation Items. In the MTMM matrix, the values representing the leading diagonal are significantly greater than the correlation coefficients for non-corresponding scales off of the leading diagonal. This proves that the incentive indices derived through MISS techniques were valid measures of the respective incentives as they passed the test for both Convergent and Discriminant Validity. At the end of this three-stage CFA process (i.e., Scale Reliability, Unidimensionality and Construct Validity), we selected these 43 statements to be included in the final questionnaire.

Main Survey – Data Collection and Analysis

The procedures adopted in the Pilot Survey in the Main Survey carried out from January to September 2009 were repeated to collect data from 325 firms. The Measurement Model (MM) constructed through the *Analysis of Moment Structures* (AMOS) [version 16] software was estimated using the Maximum Likelihood Estimation (MLE), where we considered the recommendations of Hair *et al.*, (2006) to assess the validity of MM in terms of both Model Fit and Construct Validity. The summary of goodness-of-fit measures obtained highlights that

[17] Assume that the incentive (Construct) concerned comprised 5 statements (Indicators) and the "Firm Q", for example, has agreed ("yes") with the phenomenon stated in 3 statements (Indicators) and rated them by scoring 2, 3 and 5 on the five-point Likert scale and disagrees ("no") with the other 2 statements and rated them by scoring 1 and 4 on the same scale. The Aggregate Score (AGS) of the 5 statements would, therefore, be 2 + 3 + 5 – 1 – 4 = 10 – 5 = 5. The Maximum Potential Score (MPS) for this incentive was 5 x 5 = 25 (i.e., the firm very strongly agrees with all the statements and score 5 on the five-point scale). The value of the Incentive Index for this particular incentive for Firm Q was, therefore, 5 / 25 = 0.20. Further, assume that another firm ("Firm R") agreed with 2 statements specified for the same incentive by scoring 1 and 3 on the five-point Likert scale and disagreed with the rest of the statements and scored 3, 2 and 5 on the scale. The Aggregate Score was 1 + 3 – 3 – 2 – 5 = 4 – 10 = – 6 and the value of Incentive Index was – 6 / 25 = – 0.24.

the overall model X^2 is 1901.67 with 824 degrees of freedom (df). The probability value associated with this result is 0.000 and the model is significant at $\rho = 0.001$. Also the ratio of X^2/df was 2.308 (i.e., 1901.67/824), which was below the accepted cut-off value of <3.00. As a minimum requirement, the estimates of Factor Loadings (given as Regression Weights in AMOS) should be statistically significant to support Convergent Validity (Dunn *et al.*, 1994). Hair *et al.*, (2006) recommend that the standardised Regression Weights should be 0.5 or higher, ideally 0.7 or higher. The outcome shows that all loadings of the estimated model were significant while 31 out of 43 statements considered had standardized Regression Weights above the 0.7 cutoff, with only 5 statements (i.e., CPR2, EGR2, EGR3, AGR4, and LBL3) were having standardized loadings below 0.5.

Next, using the λ = Standardized Factor Loading and n = Number of Items, we estimated the Average Variance Extracted (AVE) and Construct Reliabilities (CR), where the AVE = $\Sigma\lambda_i^2$/ n and CR = $(\Sigma\lambda_j)^2$/ $(\Sigma\lambda_j)^2+\Sigma(1-\lambda_j^2)$ respectively (Garver and Mentzer, 1999). The rule of thumb for CR is that it should be 0.6 or higher but, ideally, 0.7 or higher to indicate that reliability is good with internal consistency (Fornell and Bookstein, 1982). For AVE, a value of 0.5 or higher suggests adequate convergence while the scale has higher distinct validity (Fornell and Larker, 1981). We report the results in Table 1. The CR estimates for all but two incentives (EGR and AGR) are above the ideal 0.7 cutoff but even these two incentives are above the generally acceptable 0.6 cutoff. Only three incentives of the AVE (CPR, EGR and AGR) are below the 0.5 cutoff. This has resonance with the low Regression Weights obtained for indicators of these incentives.

For all nine incentives as a whole, the indicators were sufficient in terms of how the MM was specified. The satisfaction of conditions for all the Regression Weights, CR, and AVE support the Convergent Validity of the MM to a reasonable extent. However, there is a need to consider whether the indicators have low loadings which need to be pruned. The recommended approach for establishing Discriminant Validity[18] is to compare the Squared Correlation between two constructs with either of their individual AVE estimates. The AVE estimates should be greater than the squared correlation estimate. Table 2 shows that 27 out of the 36 inter-construct combinations satisfied the criterion and only 9 inter-construct correlations (highlighted in yellow) exceed the AVEs of either of the Latent Constructs (Hair *et al.*, 2006).

Apart from the analysis through AMOS, the MTMM matrix derived for this stage, which utilized the scores provided by 325 firms to the 9 single-item Validation Items and the Incentive Index derived for the corresponding 9 incentives, also show that the values in the leading diagonal (highlighted) are not only significantly greater than the correlation coefficients for non-corresponding scales off of the leading diagonal (Table 3). In fact, the corresponding values in the leading diagonals reported in Table 3 are greater than that obtained in the Pilot Survey proving that the selected indicators perform quite satisfactorily with the large sample. At the end of this process, we considered all the statements included in the questionnaire to derive the Incentive Index of each incentive since those minute deviations from the accepted norms in certain statements cannot have a sizeable impact on the overall result.

[18] In addition to the distinctiveness of Constructs, Discriminant Validity also means that individually measured items should represent only one Latent Construct. The presence of cross-loadings indicates a Discriminant Validity problem. If high cross-loadings do indeed exist, and they are not represented by the measurement model, the CFA fit should not be good (Hair *et al.*, 2006).

Table 2: 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*

Table 3: Multi-Trait Multi-Item Matrix for the Main Survey

		Validation Item								
		V_1	**V_2**	**V_3**	**V_4**	**V_5**	**V_6**	**V_7**	**V_8**	**V_9**
Index Values	**CST**	-.934(**)	.438(**)	.644(*)	-.079	.211(*)	.325(*)	-.187	.099(*)	.577(*)
	TCE	-.643(**)	.769(**)	.794(**)	-.213(*)	.452(*)	.577(**)	.232(*)	.491(*)	.222(*)
	HRE	-.762(**)	.743(**)	.903(**)	-.297(*)	.571(**)	.577(**)	-.039	.401	.204
	SLR	-.721(*)	.511(**)	.562(*)	-.301(*)	.467(**)	.652(**)	-.328	.156	.447(*)
	CPR	-.422(*)	.691(**)	.551(*)	-.623(*)	.910(**)	.439(*)	.596(**)	.559(*)	.502(*)
	REP	-.688(**)	.634(**)	.710(**)	-.581(**)	.721(**)	.729(**)	-.478(*)	.401	.662(**)
	EGR	-.211(*)	.483(*)	.467(*)	-.344(*)	.590(**)	.298(*)	.884(**)	.725(**)	.491(*)
	AGR	-.578(**)	.775(**)	.751(**)	-.461(*)	.872(**)	.455(*)	.782(**)	.732(**)	.509(*)
	LBL	-.453(*)	.629(**)	.565(**)	-.678(*)	.559(*)	.601(**)	.672(*)	.572(*)	.728(**)

Note: V = Validation item representing corresponding incentives

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).
[a] Cannot be computed because at least one of the variables is constant.

RESULTS AND DISCUSSION

Characteristics of Firms in the Sample

The data from 325 firms were categorized under five product types: (1) Coconut Products [COP] = 31 (9.5 percent (2) Essential Oils [ESO] = 59 (18.2 percent (3) Non-Alcoholic Beverages [NAB] = 72 (22.2 percent (4) Other Processed Products [OPP] = 70 (21.5 percent and (5) Processed Fruits and Vegetables [PFV] = 93 (28.1 percent) (Figure 5).

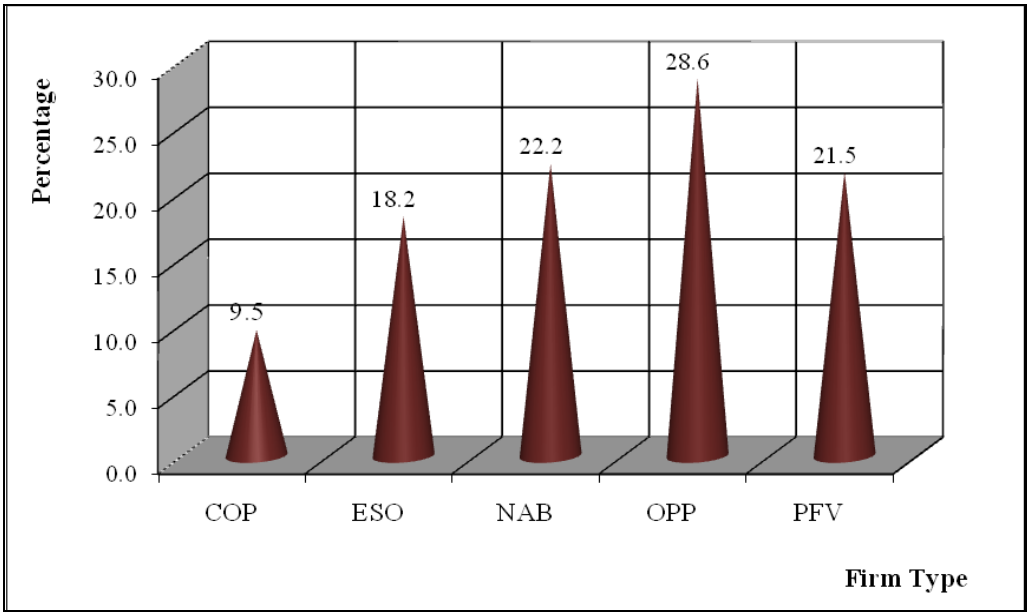

Figure 5: Percentage of Firms by Type

Another classification, again into 5, took into account a firm's value of annual sales, namely: (i) Very Small (< Rs. 100,000) [n = 80; 24.6 percent (ii) Small (Rs. 100,000 – 500,000) [n = 70; 21.5 percent (iii) Medium (Rs. 500,000 – 1,000,000) [n = 50; 15.4 percent (iv) Large (Rs. 1,000,000 – 5,000,000) [n = 56; 17.2 percent and (v) Very Large (> Rs. 5,000,000) [n = 69; 21.2 percent (Figure 6). Interestingly, the majority of firms producing essential oils (64.4 percent) and other processed products (67.1 percent) were either Small or Very Small. On the other hand, the firms engaged in producing coconut products (48.3 percent) and non-alcoholic beverages (65.2 percent) were either Large or Very Large.

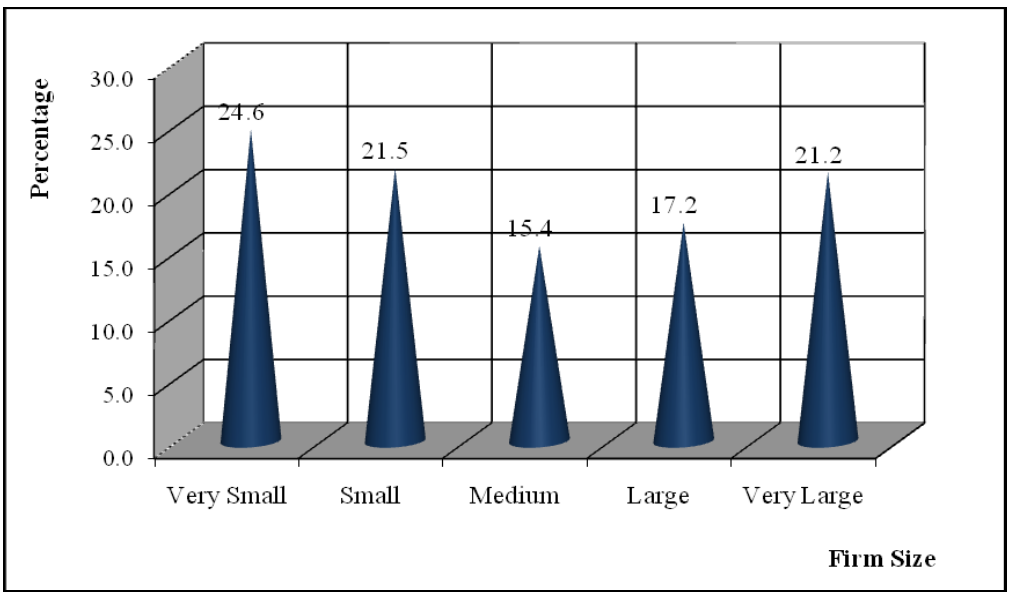

Figure 6: Percentage of firms by size

Nearly 40 percent of firms were involved in international markets (i.e., exporting). Further, about 50.5 and 46.5 percent of firms traded with wholesalers and direct customers. Nevertheless, a significant variation was observed with regard to size of the firm and the type

of customer they dealt with. Almost 71 and 59 percent of Very Large and Large firms, respectively, exported their products while only 23 and 1.3 percent of Small and Very Small firms did so.

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

Figure 7 illustrates that "Composting" (31.4 percent), "3R system" (24 percent) and "Good Manufacturing Practices" (24 percent) were popular as measures to control solid waste generated in the firm as compared to "Bio Gas Unit" (4 percent) and "ISO 14000 series" (4.6 percent). Out of the 325 firms contacted, however, 153 firms (47.1 percent) did not adopt a single SWMP suggested by the MENR. Another 85 (26.2 percent), 31 (9.5 percent) and 23 (7.1 percent) firms have adopted only 1, 2 or 3 out of the 8 practices respectively. Only 17 (5.3 percent) firms have more than 5 SWMPs in place (Figure 8).

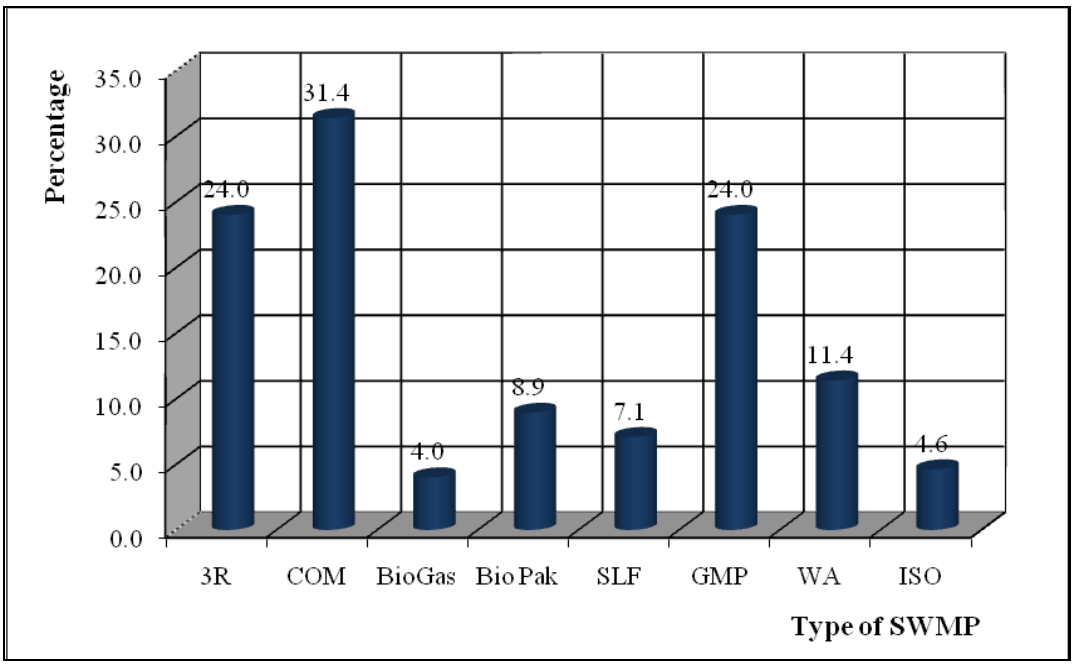

Figure 7: Different types of SWMPs adopted by firms

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 produced non-alcoholic beverages (NAB) and processed fruits and vegetables (PFV) tended to adopt a higher number of SWMPs in comparison with those that processed essential oils (ESO) and coconut products (COP). In fact, nearly 75 percent, 63 percent and 61 percent of essential oil (ESO), other processed products (OPP) and coconut product (COP) processing firms, respectively, did not adopt a single SWMP. With regard to firm size, large firms, not surprisingly, tended to adopt a higher number of SWMPs. For example, nearly 29 percent of Very Large firms adopted more than 4 such practices in the firm compared to 71.3 percent of Very Small firms who did not adopt a single practice.

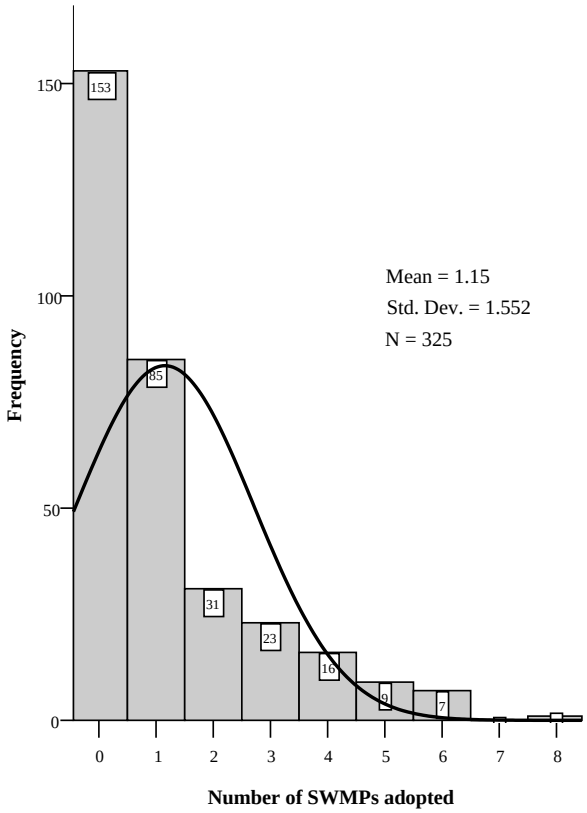

Figure 8: Total number of different SWMPs adopted by firms

Figure 9 illustrates the values of the Mean Incentive Index (MII) for each of the 9 incentives considered in this analysis vis-à-vis the number of SWMPs adopted.

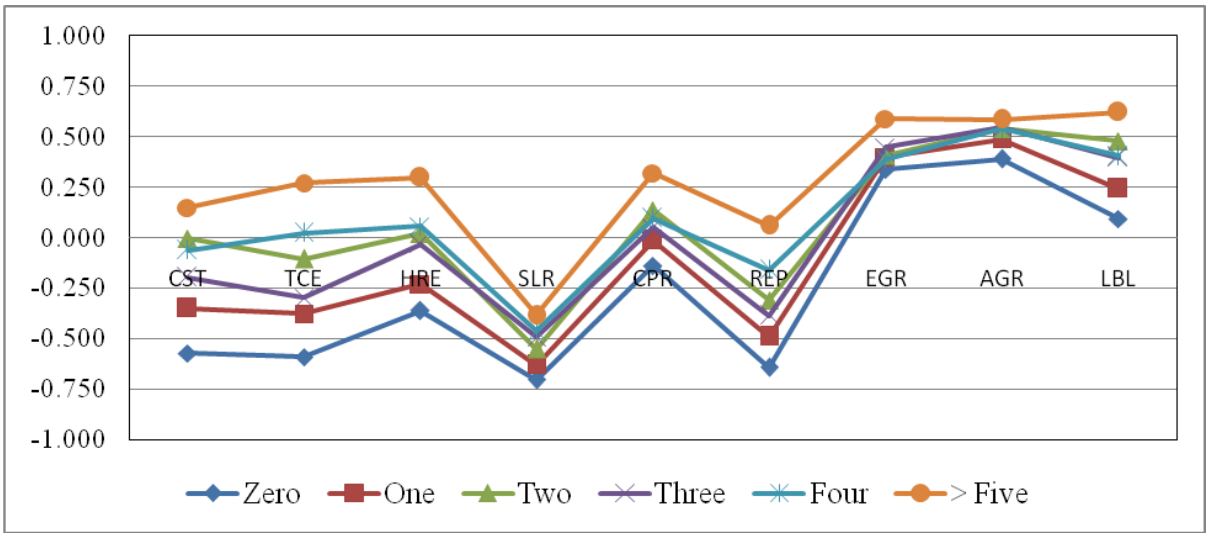

Figure 9: No. of SWMPs adopted by a firm and value of incentive index

It shows that for firms either without or with a small number (i.e., one or two) SWMPs, the value of the MII of most market-based incentives were either negative (e.g., CST, HRE, TCE, SLR, REP) or only slightly positive (e.g., CPR). Further, the values of the MII of regulatory and liability incentives were positive irrespective of the number of SWMPs in place. In fact, it tells us that as the value of the MII of all these incentives increases, firms tend to adopt a

higher number of SWMPs. The results also suggest that the magnitudes of the Incentive Index, which reflects the relative strength of an incentive, is perceived by the majority of the firms, on average, between -0.5 to 0.5 indicating that most firms, especially the Very Small to Medium scale firms, did not consider these incentives as very important in their decision to adopt SWMPs. It shows that the firms' level of adoption of these SWMPs were relatively low with mean of 1.2 practices in place out of the 8 such practices recommended by the Ministry of Environment.

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. The results show that it was distributed with a Mean (Standard Deviation) of 1.153 (± 1.559) (i.e., Variance = ± 2.430). This shows that there is an over-dispersion. Therefore, we decided to estimate a model other than the Poisson model in which the two are constrained to be equal. Also the histogram of the response variable obtained (see Figure 7) shows that the number of zeros is excessive. These suggest that it is best to estimate the econometric model with other option/s available, including Zero-Inflated Poisson (ZIP) and Zero-Inflated Negative Binomial (ZINB) models that could account for this over-dispersion. We report the statistical outcome of ZIP and ZINB models in Table 4.

The Vuong statistic (V=3.36) compares the ZIP and PR models. Since it is significant, we prefer ZIP to the PR model. Where NBM is considered, the Vuong *t*-test (V=5.65) result further suggests that the ZINB outperforms its parent specification, the Negative Binomial model (NB). The appropriate model for the data on adoption counts suits more with the ZIP or ZINB model. This test is also supported by the Likelihood Ratio (LR) test that we carry out to investigate whether or not the ZINB model reduces to the ZIP model. The results from this test demonstrate that the LR test statistic computed as LR =−2[LVZIP −LVZINB)], where LV stands for log-likelihood values and distributed as Chi-square with one degree of freedom, favors the ZINB model over the ZIP model.

The coefficient of CST is negative for both ZIP and ZINB models and significant at 5 percent implying that with every unit increase in the cost there is decrease in the adoption of the recommended practices at the firm level. However, it could be identified that as cost is a negative incentive, if the firms are financially supported there is a high potential to increase the adoption. TCE is statistically significant in ZINB model, which implies that if the adoption of these technical standards tends to increase the technical efficiency of the firms that will act as a positive incentive leading to a higher adoption rate. For most firms, especially for the small and medium-scale firms, technical efficiency can be considered a critical factor for implementation of SWMPs as it has a direct impact on their production.

Interestingly, the coefficients of all other incentives, including HTE, SLR, REP and CPR were not statistically significant in either of the two models suggesting that they did not exhibit an impact on the adoption. In fact, the firms judged that adoption of SWMP has no role play with in terms of increasing their sales and revenue sales and revenue. This is in contrary to the outcomes reported in previous research which focused on problems related to environmental 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 play a less significant role in our study when it comes to motivating firms to adopt SWMP.

Table 4: Outcome of Count Data Analysis

Covariates	Zero Inflated Poison (ZIP)			Zero Inflated Negative Binomial (ZINB)		
	Coe.	*SE*	*Prob.*	*Coe.*	*SE*	*Prob.*
Individual Incentives						
CST	-0.946	0.314	0.003	0.785	0.337	0.020
TCE	0.767	0.364	0.035	0.678	0.397	0.048
HRE	0.132	0.276	0.631	0.021	0.276	0.939
SLR	0.308	0.410	0.452	0.189	0.355	0.594
CPR	0.240	0.438	0.240	0.165	0.330	0.618
REP	0.138	0.320	0.665	0.161	0.327	0.622
EGR	0.177	0.288	0.538	0.138	0.286	0.630
AGR	0.247	0.330	0.022	0.133	0.302	0.032
LBL	0.081	0.242	0.035	-0.136	1.737	0.048
Constant	-3.047	4.584	0.117	4.758	3.152	0.651
Sector Dummies						
ESO	0.961	0.575	0.095	0.540	0.336	0.108
NAB	-0.459	0.551	0.405	-0.097	0.267	0.717
OPP	-0.498	0.572	0.384	-0.162	0.330	0.623
PFV	-0.122	0.546	0.822	-0.235	0.268	0.380
Scale Dummies						
Very Large	1.108	0.578	0.056	0.839	0.463	0.070
Large	1.056	0.433	0.015	0.817	0.337	0.015
Medium	0.889	0.355	0.012	0.781	0.302	0.010
Small	0.650	0.296	0.028	0.600	0.269	0.026
Vintage (VT)	0.926	0.128	0.000	0.958	0.124	0.000
Export (EX)	-0.080	0.131	0.543	0.075	0.135	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

The regulatory incentive of EGR is not statistically significant. Therefore, we cannot consider which as an important factor determining the level of adoption, in general. This clearly suggests that existing failures in government policy has led firms to non-compliance with those recommended environmental practices. This is supported by the significance of AGR and LBL. The anticipated changes in government regulations would lead the firms to reduce the adoption of these practices. This can be judge as firms are practicing the "wait & see" policy as they believe that national and local governments are changing their policy scenario very frequently. Parallel to failures in government policy, firms did judge that a stricter legal system can motivate them positively to adopt a higher number of SWMPs in the firm. It could be seen that firms may view strict liability as better suited towards mitigation, that they may anticipate engaging in "precaution targeting". And the non-adopters may have fewer resources available to confront existing environmental problems, may not wish to discourage

business activity, or may have other programs in place which effectively substitute (at least for a short time) incase strict liability is imposed for these firms in the future.

Where the different sector is of concern, it was evident that there was no sector wise (FT) significance towards the adoption decision. However, the scale of the firm (FS) possesses a potential impact. The ZINB model shows that, in relation to the very small scale firm, all other firm showed higher affinity towards the adoption where, the very large firms display the relatively highest adoption rate which again proves the negativity of cost as an incentive. The number of years a firm has been in existence (VT) does have a significant impact on the adoption decision, or in other words, the more the years of existence of a firm, higher the rate of adoption of these practices by a firm, irrespective of the sector and its size. This interestingly suggests that, as a firm grows old and establish, the sense of responsibility towards environmental quality increases leading them to focus more attention on cleaner production and pollution control. However whether the firm is a product exporting company (EX) or not does not have a significant impact on the adoption. This may be due to the fact that certain environmental standards unlike food quality standards do not critically affect exportation to a considerable extent.

The results, in effect, reject the hypothesis that a firm's adoption decision is triggered by potential losses to the firm resulting from its failure in the market due to non-responsivenes to market-based incentives and that this effect is greater than the potential gains to the firm resulting from those failures in government policy that would account either for its degree of compliance or total non-compliance. The outcome suggests that firms, in general, did not take into account such failures in the market 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, etc., arising from its non-compliance with market-based incentives. However, firms recognized potential failures in government policy and inefficiencies associated with the legal system. In sum, it is the less significant losses in the market combined with the relatively high gains due to failures in government policy that provide an opportunity for firms, by and large, to not respond positively to environment quality by adopting advanced environmental management controls. However, the outcome of the analysis accepts that the relative strength of an individual incentive faced by a firm is not the same across all firms and is associated significantly with both the characteristics of the firm and the regulatory regime.

Conclusions and Policy Implications

The results of this analysis suggest that it is important to design private and public sector initiatives, which aim at achieving a higher level of environmental quality at the level of firm that are incentive-based in order to augment the low levels of market-based incentives currently prevailing at the firm level. However, such initiatives should factor in the differing industry structures and sizes of firms.

The results of the analysis can be used to develop a common format for decision-making with respect to the level of solid waste management controls adopted by the Sri Lankan food processing enterprises, in which both the national and provincial governments on the one hand allows for producers to take advantage of potential market opportunities that exist while strengthening controls by the judicial system on the other. More specifically, decision-makers can use the analysis to critically review, revise and make necessary adjustments to policies and legislation on environmental quality at the national level and provincial levels since

many such policies do not take into account the food producers' capacity and ability to respond to such policies and laws effectively.

The analysis highlights the fact that the problem faced by these food processing firms in the current context of regulation is not simply maintaining their level of responsiveness to environmental quality but managing both private and public environmental management controls that operate side by side. They have to minimize, on the one hand, production and transaction costs while avoiding, on the one hand, the repercussions of non-compliance. Consequently, any attempt by public regulatory agencies to upgrade existing environmental quality management practices and to mandate them, in turn, across the sector without considering what the private incentives are of these firms to behave responsibly in terms of environmental quality raises several issues. One such issue is the failure of governments to take into account their own lapses, and also those of the judicial system, when imposing ever-increasing restrictions on the market. These restrictions can, in turn, diminish the value of private collective actions on the part of market-based institutions and/or aggravate so-called failures of the market. A second issue centers on how the government justifies such a mandate at the expense of the taxpayer when there is evidence to show that firms themselves possess incentives to achieve the same goal using their own resources. The findings of the study suggest that the firms under study are anticipating much stricter regulations in the near future. It is clear that this perception on government regulation, together with their desire to respond to market-based and liability incentives, can effectively regulate these firms. In fact, the differing performance levels of these firms with respect to the different solid waste management practices proposed suggest that the majority of firms perform poorly in one or more important areas, for example, in the adoption of waste management systems and audit procedures that are required to assure a higher level of environmental quality. It is therefore imperative that regulations be altered at the provincial government level to overcome these shortcomings in the current regulatory system.

The discriminatory behavior of public regulatory bodies at the national and provincial levels raises the question as to what criteria are appropriate in controlling the level of environmental quality. In fact, it is possible that the situation would improve if individual firms were allowed to participate directly in decision-making with respect to the level of environmental quality controls that they would adopt while other players in the market (such as industry and trade organizations) and the government were to play a more facilitative role in augmenting firm-level incentives. Policy makers could use the 'carrot and stick' approach suggested by Segerson (1999) which imposes voluntary and mandatory public food safety controls at the firm level as the basis for designing appropriate regulation for environmental controls, which, in turn, could produce an incentive-based regulatory system for all firms. Segerson's 'carrot and stick' standards are in fact designed by regulators while firms are asked to implement the proposals voluntarily (i.e., regulator-to-firm approach), which is the most commonly used 'top-to-bottom' approach in developed countries. An alternative would be a 'bottom-to-top' approach (i.e., firm-to-regulator approach) that would reflect the individual incentives faced by firms and takes into account the characteristics of firms and of the market in which they operate.

By redefining its current regulatory role, the government, together with the other sectors in the market (such as industry and trade organizations), can act as a facilitator for firms to develop appropriate environmental quality management programs that reflect their private incentives. Trade and other industry organizations, as an integral part of the market, can in turn play an extensive role in this connection to minimize the problems faced by firms. In fact,

the role of these organizations could be extended to include negotiation. Here, they would act as mediators between the firm and the government on matters concerning appropriate standards and codes of practices. In addition, where applicable, they could replace, at least in part, government regulation by developing standards comparable to regulatory requirements.

Accordingly, there are a number of ways that such market-oriented institutions can improve the adoption by individual firms of higher levels of environmental quality controls. They could, for instance, amalgamate their own policies with firms' protocols to develop a single regulatory regime, act as facilitators by providing expert knowledge and sharing information (this may be especially important for small-scale firms), formulate blue prints for controls in different sectors of the industry, provide financing options for members, and perhaps, conduct benefit-cost and sensitivity analysis to evaluate industry performance with respect to differing standards. Such a positive role on the part of these institutions would inevitably augment the private incentives of individual firms and could help to minimize any failures associated with the functioning of the market for environmental quality. More importantly, they could reduce the transaction costs faced by individual firms in arranging these functions.

At the same time, the 'carrot and stick' approach of Segerson (1999) should also be available since the results confirm the strong role of regulation as compared to other incentives. Both the government, industry and trade organizations should constitute a credible threat to firms that do not comply with regulations. As a 'stick', the government could develop a more stringent 'command and control type environmental quality management program for all firms and apply it irrespective of the characteristics of the firm such as its size or whether it functions in the domestic or international markets. This course of action could be strengthened with a set of penalties (i.e., fines, license suspension and temporary closure, etc.), as well as the emplacement of an effective system to expose those firms that do not comply. This kind of approach may act as an incentive-based regulatory system in the sense that it is a form of subcontracting of regulatory functions to the industry and trade organizations. However, at the same time, non-compliance would entail the credible threat of direct government intervention. Last but not least, one of the most important implications of designing regulation in this manner is that it provides the right to determine the boundary between the market and the government not only to the government but to the market institutions themselves as well.

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