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Motives for Sri Lankan Agri Food Processing Firms to Adopt Solid Waste Management Practices: A Count Data Analysis

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ABSTRACT

This study examines the potential relationship between various incentives and plant level characteristics (i.e. Type and Size) of a firm to adopt recommended solid waste management practices in the agri-food processing sector in Sri Lanaka with a special focus on the perpetual changes of firms' decision makers over time. The data collected from a cross section of firms representative to the industry structure (n=146) through a structured questionnaire administered with environmental managers/owners during January to April 2012 (Stage II) were matched with corresponding data collected two years earlier (Stage I) from the same set of firms (i.e. panel data) from which indices were formulated to estimate the relative impact of incentives. The Count Data Model was specified to assess the relationship between incentives and levels of adoption of SWMPs. The results suggest that the level of adoption of these practices on an average has increased over time (shift of Mean from 1.25 in Stage I to 1.86 in stage II). Irrespective of time, cost, technical efficiency and liability laws had a significant impact on the augmented adoption while sales and revenue was additionally perceived to be important respect over time. The outcome emphasizes the importance of bringing the current public regulatory regimes towards co-regulation alongside a market-based incentive framework to increase the level of adoption of environmental controls towards sustainability.

KEYWORDS: Count data, Economic incentives, Food processing firms, Solid waste management

INTRODUCTION

The literature on environmental economics and management points out three board ways to maintain environmental quality. These include studies that focus on (1) different type of government regulation that affect incentives for abatement and the associated costs; (2) informal regulations by citizens and market characteristics that can lead firms to improve environmental performance, and (3) the voluntary environmental protection, which is to be carried out by a firm on its own willingness [private] (Hettige *et al.*, 1996). For the purpose of this study, we used the special case of adoption of enhanced environmental controls, which was formulated by the Ministry of Environment (and Natural Recourses then) [MENR], by firms operate in the agri-food processing sector in Sri Lanka.

Being the largest manufacturing sector in Sri Lanka with more than 80 present of firms operate in the provinces of very high popular density, for example more than 500 people per km^2, the generation and unhygienic accumulation of solid waste through these agri-food processing firms has become a growing problem in Sri Lanka. As a solution to this problem, the MENR has already formulated the *"National Strategy for Solid Waste Management"* and number of specific procedures that firms in the food processing sector should adopt in order to manage the solid waste generated in a firms are introduced. These include: (1) *"Sorting of waste based on 3R system"* – establishment of necessary infrastructure facilities in appropriate place and allocating labour for the purpose; (2) *"Composting"* – the conversion of solid waste materials into compost, in which the heavy metals composition should be maintained below the recommended standards; (3) *" Biogas Technology"* – establishing unit in accordance with the guidelines provide by the MENR; (4) *"Biodegradable packing materials"* – using materials such as a paper, glass, cloth, etc. instead of polythene and other non biodegradable plastic; (5) *"Sanitary land filling"* – the maintenance of a site for which the firm should obtain clearance based on the guidelines provided by the Central Environment Authority (CEA) in Sri Lanka; (6) a set of *"Good Manufacturing Practices"* (GMP); (7) Regular *"Waste Auditing"* system; and (8) ISO 14000 *Environmental Management System.* An individual business can select either one or combination of these practices or any other appropriate mechanism that they deem to be effective in rectifying the problem associated with the generation of waste in their premises.

How the perception on different incentives change overtime has, however, not been explored empirically to date, to the best knowledge of authors, especially in the context of Sri Lanka. Jayasinghe-Mudalige and

Udugama (2010) empirically explored the impact of market based and regulatory incentives for agri-food processing firms to adopt solid waste management practices in their firms. The aim of this study was therefore to identify the impact of various incentives and firm level characteristics on the adoption of recommended SWMPs by the firms in the agri-food processing sector with a special focus on the perceptual changes over time.

METHODOLOGY

Conceptual Framework

We can conceptualize that there are four social processes, namely: (1) market; (2) political (3) judicial and (4) ethical motives (altruism) that can influence firms in implementing environmental management controls. The responsiveness of a firm towards the environment (D) is reflected by different environmental management practices (SWMPi) 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...m) and the characteristics of the firm (F_{ki}), where k = size or type of the firm. Following Nakamura *et al.*, (2001) from the maximization of the utility function, we derive the following empirical expression of the determinants i^{th} firm's environmental management practices

$$SWMP = \alpha i + \beta_j I_{ji} + \gamma_k F_{ki} + \epsilon_I \; (1)$$

The incentives and plant level characteristics (i.e. firm type/size) act as independent variables. (Jayasinghe-Mudalige and Henson, 2006a; 2006b; Anton, 2002).

Empirical Model

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

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

Where, $SWMP_i$ denotes the dependent variable (i.e., solid waste management practices adopted by a firm). The right hand side variables include: $\sigma 0$ = intercept, βj = coefficients of 9 individual incentives (j = 1, 2...9) considered in the analysis and γ_k = coefficients of characteristics of a firm (Fki) denoted by dummy variables such that FT = firm type, FS = firm size; VT = Vintage (1 = $\geq$10 years; 0 = <10 years), CST = Cost and Financial Implication, TCE = technical Efficiency, HRE = Human Resource Efficiency, SLR = Sales and Revenue, CRP = Commercial Pressure, REP = Reputation, EGR = Existing Government Regulation, AGR = Anticipate Government Regulation, LBL = Liability Laws ALT = Altruism

Data Collection and Analysis

The data pertaining to the Stage I was obtained from *SANDEE Database* used in Jayasinghe-Mudalige and Udugama (2010) that includes the primary data on numerous aspects related to a firm's performance on environmental quality management of 325 agri-food processing firms in Sri Lanka belonging to five different sub-sectors. We have identified that certain firms selected into the sample were not in operation (i.e. plant-exit) or under-operation (i.e. partial-exit) and/or the ownership/management has changed from Stage I. With all efforts, the collection of data was confined to 146 firms. Participated to Stage I carry out the Stage II of the study. The data for Stage II were, therefore, collected during January and April 2013.

A letter of request for an appointment together with the summary of outcome of Stage I was sent to all selected firms, and was simultaneously Face-to-face interviews supported by the structured questionnaire were used to collect the data. The data collected from each firm in Stage II were coded in a database, which was derived from the original SANDEE database were matched with the corresponding data from Stage I to facilitate count data analysis.

Count Data Model

Solid waste management practices adopted by firms are counts. Therefore, in this study count data analysis was used Count data is a statistical data type, in which the observation can take only the non – negative integer values {0, 1, 2, 3, ...}, and where these integers arise from counting rather than ranking.

Having coded the data appropriately and performed the standard tests for the missing data in certain cases, the "Statistical Package for Social Sciences" (SPSS) [Version 20] was used to obtain the results of the PCA (Principle Component Analysis) after which indices were made to reflect the different incentives of concern (Jayasinghe-Mudalige and Udugama, 2010; Udugama and Jayasinghe-Mudalige, 2011). The Stata [Version 11.2] was used to obtain the output of Count Data model.

RESULTS AND DISCUSSIONS

Characteristics of Firms in the Sample

Data collected from 146 firms were categorized into five types on the basis of their produce: Coconut Products [COP] (20.6%), Essential Oils [ESO] (19.9%), Non-Alcoholic Beverages [NAB] (28.1%), Other Processed Products [OPP] (14.4%) and Processed Fruits and Vegetables [PFV] (17.1%)

The most popular SWMP in Stage I and Stage II were composting (30.8%) and GMP (52.1%) respectively (Figure 1).

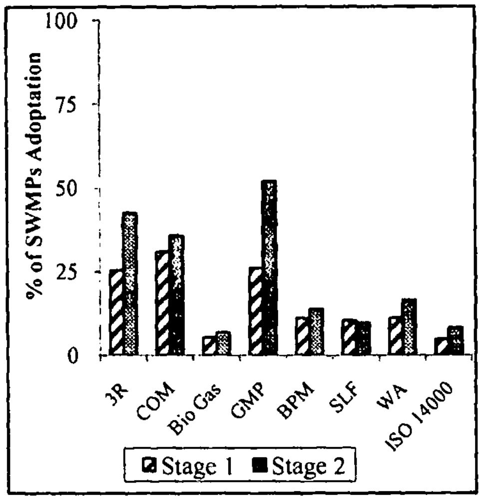

Figure 1. Percentage of SWMP adaptation

In Stage I, almost 46.6 % of firms in the sample did not adopt a single SWMP suggested by the MENR. Another 37 (25.3%), 15 (10.3%), 5 (3.4%), 10 (6.8%), 6 (4.1%) and 5 (3.4%) firms have adopted only 1, 2, 3, 4, or 5 out of the 8 practices respectively (Figure 2). In Stage II, almost 15.07 % of firms in the sample. i.e. 22 firms did not adopt a single SWMP suggested by the MENR. Another 50 (34.4%), 35 (23.9%), 19 (13.0%), 11 (7.5%), 4 (2.7%) and 5 (3.4%) firms have adopted only 1, 2, 3, 4, or 5 out of the 8 practices respectively (Figure 2).

In the Stage I, the first step towards a Count Data Analysis was to examine the excess zeros and over-dispersion of the data. The results showed that the data were distributed with a Mean (Standard Deviation) of 1.25 (1.672) (i.e., Variance = ± 2.795). In the Stage II, the first step towards a Count zeros and over-dispersion of the data. Data Analysis was to examine the excess.Results showed that the data were distributed with a Mean (Standard Deviation) of 1.86 (1.472) (i.e., Variance = ± 2.167). 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.

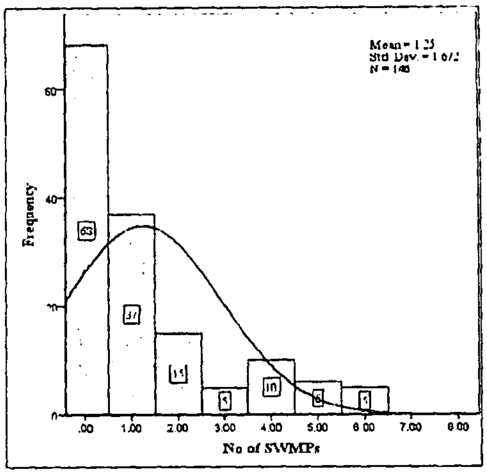

Figure 2a. Total no of SWMPs adopted by firms – Stage I

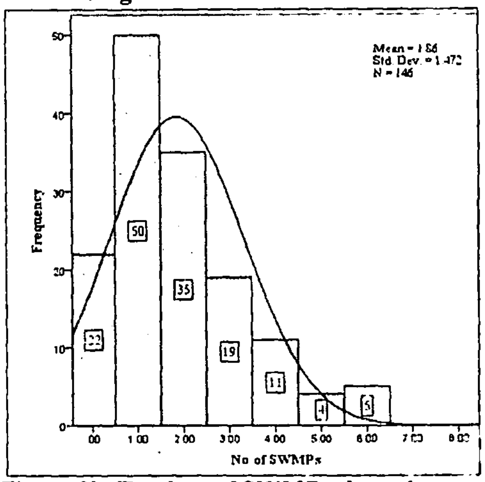

Figure 2b. Total no of SWMP adopted byfirms –Stage II

Figure 2. No of SWMPs adopted by firms

Also the histogram of the response variable obtained shows that the number of zeros is excessive (Figure2a). These 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. We report the statistical outcomes of the ZIP and ZINB models in Table 1.

Outcomes of Count Data Analysis

As a result, the dependent variable would be in the form a non negative integer-valued count and the appropriate statistical model could be the Poisson Regression model. However, in most economic applications, the integer-valued count data encompasses over-dispersion meaning that the Conditional Variance exceeds the Conditional Mean. In such cases, Poisson model cannot be used.

Table 1. Outcome of Count Data Model

Covariate	Zero Inflated Poison (ZIP)				Zero Inflated Negative Binomial (ZINB)			
	Stage I		Stage I I		Stage I		Stage I I	
	Coe.	Prob	Coe	Prob	Coe	Prob	Coe	Prob
Incentives								
CST	-0.155**	0.022	-0.273**	0.013	-0.155**	0.022	-0.273**	0.013
TCE	0.159**	0.033	1.300**	0.020	0.159**	0.033	1.300**	0.020
HRE	0.786	0.330	1.821	0.172	0.786	0.330	1.821	0.172
SLR	-1.365	0.154	-2.574**	0.014	-1.365	0.154	-2.574**	0.014
CRP	1.020	0.110	0.147	0.801	1.020	0.110	0.147	0.801
REP	2.022***	0.003	0.132	0.712	2.022***	0.003	0.132	0.712
EGR	-2.175*	0.090	1.465	0.188	-2.175*	0.090	1.465	0.188
AGR	0.027**	0.031	-0.529	0.282	0.026**	0.031	-0.529	0.282
LBL	0.245**	0.025	0.144**	0.016	0.244**	0.025	0.144**	0.016
Altruism	2.373	0.412	0.495	0.061	2.373	0.412	0.495	0.061
Constant	0.357.	0.583	1.61*	0.061	0.357	0.583	1.61*	0.061
Firm Characters								
PFV	-0.018	0.941	-0.018	0.941	-0.018	0.941	-0.118	0.651
ESO	-0.192**	0.038	1.445***	0.01	-0.192**	0.038	1.445***	0.01
NAB	2.046	0.203	1.625***	0.001	2.046	0.203	1.625***	0.001
OPP	1.43	0.583	-0.725	0.106	1.43	0.583	-0.725	0.106
Large	-0.222**	0.014	-0.93**	0.041	-0.222**	0.014	-0.93**	0.041
Medium	-0.199	0.672	-0.621	0.128	-0.199	0.672	-0.621	0.128
Vintage	-0.295	0.212	-0.142	0.465	-0.295	0.212	-0.142	0.465
Log like hood	-94.08		-167.38		-94.08		-144.03	
LR chi2	21.25		24.01		20.25		154.15	
Model	Probit		Probit		Logit		Logit	
Vuong test	7.38**		4.11**		12.97		0.0344	
Likelihood ratio test					1.000**		1.000**	
Prob>chi2	0.1691		0.0649		0.000		0.000	

Note: ****Significant at prob = 0.01; **Significant at prob = 0.05; *Significant at prob = 0.10*

In such cases, Poisson model cannot be used. In addition, a relatively higher frequency of zero observations on the dependent Variable is another frequently encountered issue in empirical studies. Thus, with a large proportion of zero observations and the potential presence of over-dispersion, the Poisson Model is not appropriate.

Given that in stage I 68 out of 146 firms (46.6%) and in stage II 22 out of 146 firms (15.07%) in the sample did not adopt even a single SWMP (i.e. non-adopters), the Zero-Inflated Poisson (ZIP) and Zero-Inflated Negative Binomial (ZNIB) models were selected for the analysis. The ZIP regression was performed initially.

In both stages the Vuong test of ZIP versus standard Poisson (probability value = 0.000) proved that ZIP model is preferable to the parent Poisson distribution. Next, the ZINB regression analysis was performed and in both stages insignificant dispersion parameter alpha (α) with the probability of 0.00 proved that there is no unobservable heterogeneity. If the dispersion parameter equals zero, the model reduces to the simpler Poisson model. As a result, the outcome ZIP model was selected as the best fitted model to explain the relationship specified in the econometric model (Table 1).

As Table 1 shows, in both stages, the coefficient of CST is negative for both ZIP and ZINB models and significant at 5 per cent implying that with every unit increase in the of adoption there is decrease in the adoption of recommended practices at the firm level.

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

In Stage I AGR do motivate firms to adopt SWMPs. It's come to the Stage II AGR is not significant. In Stage I ESO CST is negative for both ZIP and ZINB models and significant at 5 per cent implying that with every unit increase in the cost of adoption there is decrease in the adoption of recommended practices at the firm level. But when it's come to the Stage II CST is positive for both models. That mean CST firms have motives to adaptation of SWMPs. Large firms are negative so large firms are negatively response to the adaptation of SWMPs.

CONCLUSIONS

In this study, we examined the adoption of environmental, specifically, solid waste management, practices in the food processing sector in Sri Lanka. To do so, we gathered data from 325 firms in Stage I. The information gathered suggests that a majority of firms adopt very few solid waste management practices. The government of Sri Lanka has recommended that this sector adopt eight different practices – however only 1.2 practices were adopted by firms in our sample. In Stage II out of 325 there are 146 firms are responded. Only 1.85 were adopted by firms when comes to the Stage II. Both stages Composting, the 3R (reduce, reuse and recycle) based system and Good Manufacturing Practices are popular as measures to control solid waste as compared to adoption of Bio Gas Units and ISO 14000 series.

Market base intensives, cost and efficiency are influencing adaptation of SWMP. Results suggest that the level of adoption of these practices on average has increased over time (shift of Mean from 1.25 in Stage I to 1.86 in stage II). Irrespective of time, cost, technical efficiency and liability laws had a significant impact on the augmented adoption while sales and revenue was additionally perceived to be important respect over time. The outcome emphasizes the importance of bringing the current public regulatory regimes towards co-regulation alongside a market-based incentive framework to increase the level of adoption of environmental controls towards sustainability.

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