Role of Regulation for Firms to Adopt Environmental Controls: An Analysis Based on Panel Data on Solid Waste Management in Agri-Food Processing Sector in Sri Lanka

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ABSTRACT

Utilizing panel data, this study incorporates time dimensions into the empirical analysis carried out by Jayasinghe-Mudalige and Udugama (2010) to explore the potential role of individual regulatory incentives, namely: (1) Existing Regulation (EGR) (2) Anticipated Regulation (AGR), and (3) Liability Laws (LBL) on the level of adoption of solid waste management practices (SWMPs) recommended by the Ministry of Environment of Sri Lanka (e.g. 3R system, Composting unit, Biogas unit, Good Manufacturing Practices) by agri-food processing firms in Sri Lanka. The data collected from a cross section of firms representative of the industry structure (n=146) through a structured questionnaire administered with environmental managers/owners during March 2012 to April 2013 (Stage II) were taken up with corresponding data collected from the same set of firms three years earlier (Stage I). A number of quantitative techniques were employed to analyze data, including: estimation of Mean Ranks; derivation of an Environment Regulation Responsiveness Index" (ERRI) the Paired t-test and the Chi-square tests. The results imply that firms operating in this sector do not consider the existing government regulatory framework as a promising factor governing their environmental responsiveness but they do rely on the potential role of liability laws to steer adoption over time. This calls attention for adjustments to policy tools on environmental quality management at local level incorporating closely monitored, persuasive, targeted programs to promote effective compliance within firms.

KEYWORDS: *Agri-food processing sector, Environmental management, Regulatory incentives, Panel data, Solid waste*

Introduction

Solid waste management is a key environmental challenge, especially in industrialized urban areas throughout the world. Without an effective and efficient

program to manage solid waste, the waste generated through various human activities, both industrial and domestic, can result in numerous health hazards and have a negative impact on the environment. We may see that concerns for an effective and economical program to manage solid waste is ever increasing and governments and private sectors in both developed and developing countries are therefore called to pay a significant role in this connection.

Where Sri Lanka is of concern, over the past decade, the increasing amounts of solid waste generated by the industries have emerged as a pressing environmental problem. This problem of generation and accumulation of waste is exacerbated by the absence of proper management systems at the level of firm and by the existence of various types of agri-food processing industries in large numbers[1].

The environmental impact of firms on environment, especially pollution, has been subject to regulation for at least for the past three decades, under an approach which is somewhat unfairly called "*command and control*" regulation. This approach typically specifies standards, and sometimes technologies, with which regulatees must comply (i.e. "command"), and if not to be penalized (i.e. "control"). It commonly requires polluters to apply the best feasible techniques to minimize the environmental harm caused by their activities.

Command and control has achieved some considerable successes, especially in terms of reducing pollution. The problems of command and control can be overstated and its considerable achievements too easily dismissed. Nevertheless, its limitations have led policy-makers and regulators to recognize that it provides only a part of the policy solution, particularly in a rapidly changing, increasingly complex and interdependent world. The inability of social systems comprised of both markets and governments to provide efficient remedies for economic hazards underscores the importance of collaborative action between the two parties for achieving favorable "second best" solutions.

Provision of information about the environmental attributes of products and environmental performance of firms by the regulatory agency to the public has the potential to trigger product and capital market reactions and community actions that can create market based incentives for firms to improve their environmental performance. The economic problem of whether a firm can be considered as a "black box" that translates regulatory inputs into compliance outputs in a straightforward manner was, therefore, in the minds of the economists for a longer time (Henson and Heasman, 1998) as it is assumed implicitly that the internal systems within firms can easily generate the desired changes to achieve compliance; so, the non-compliance is a "rogue" outcome. When faced with a new regulation, according to Henson and Heasman (1998), firm's compliance decision does not

[1] Being the largest manufacturing sector in Sri Lanka with more than 80 percent of firms operating in the provinces of very high population density (i.e. Western, Central, North Western and Southern with more than 500 people per km^2).

involve a simple question as to whether comply or not, because it is closely related to decisions regarding 'how to comply', since a continuum of responses is available with it, ranging from 'full compliance' to 'non-compliance'.

In spite of the claims that the absence of legally binding regulations, limited institutional capacity and inadequate information hampers formal regulation, firms in many developing countries, in practice, are "fast adopters" of industrial pollution control standards. On the other hand, the high rate of non-compliance" with existing regulatory requirements illustrates that direct government intervention may not be able to fully internalize market failures and can also be subject to policy failures (Pargal and Wheeler, 1996; Hettige *et al*., 1996).

Regulation has, thus, become a major element of the environment in which firms operate that can constraint the strategic behavior of firms (Porter and van Linde, 1995) and the food industry is one example of this. In regulating businesses by way of public legislation, according to Stigler (1971), governments force them to operate within certain constraints when the social costs of private market activity are considered great and government action is needed to mitigate a market defect.

Capture theory suggests that firms may attempt to co options the regulatory process in an attempt to gain strategic advantage and this can occur at the level of the individual firm or the industry through, for example, interest groups (Peltzman, 1976). The interrelationship between the regulatory activities of government and the strategic behavior of firms is well recognized in the environmental and food economics literature though the vast majority of previous analyses on which were focused on the workings of food markets in the developed countries (Marcus, 1984), for example, reports three main strategic choices faced by a firm in its response to environmental regulation, including: (a) *stonewalling* – where the firm attempts to ignore or ride out the problems created by the regulation; (b) *opportunity seeking* – where the firm sees the regulation as an opportunity to gain competitive or other advantages, and (c) *a mixed strategy* – where new product development and heavy marketing might characterize firms' response to regulation.

Porter and van Linde (1995) argue that firms who adapt quickly to new, more stringent regulations gain a type of "first mover" advantage in the market place, which leaves them better able to compete, particularly when these regulations become more widely adopted. However, cooperate response of firms with regard to compliance to regulation may depend on the expected economic benefits in terms of improvements in industrial performance (i.e. market share and profitability) or by sanctions associated with non-compliance (Rugman and Verbeke, 1998). In the case of former, firms may choose to comply voluntarily, whilst in the latter case compliance depends on the strength of enforcement authorities.

Nehrt (1998) emphasizes that firms could benefit strategically from regulation in view of the fact that costs of compliance differ according to efficiency in compliance, which, in turn related to factors such as type and size of the firm as it

creates opportunities for large firms, in general, to obtain first-mover advantage, to enhance competitiveness relative to other firms in the market, and to erect barriers to entry or mobility. Banerjee *et al*. (2003) find that regulatory pressures and public concern were strong determinants of top management commitment to the environment which together with environmental orientation of the firm are significant determinants of its environmental corporate strategy.

Firms may also seek to preempt and shape future regulations by showing environmental stewardship and good faith efforts at improving environmental performance (Khanna, 2001). Regulatory pressures have been found to be an important motivator of voluntary environmental management by a number of studies and surveys of firms, notably Henriques and Sadorsky (1996), Dasgupta *et al*. (2000), Potoski and Prakash (2005), Florida and Davison (2001). Additionally, the threat of potential liability for Superfund sites and anticipated Clean Air Act regulations for hazardous air pollutants also motivated firms to adopt more comprehensive environmental management system (Khanna and Anton, 2002; Anton *et al.*, 2004).

On the other hand, several studies find that regulatory pressures were not important for influencing certain practices (e.g. Total Quality Environmental Management (Harrington *et al*., 2008) or in some industries (e.g. pulp mills) (Kagan *et al*., 2003). Dasgupta *et al.,* (1997) employing new survey evidence to analyze the effects of regulation, plant-level management policies, and other factors on the environmental compliance of Mexican manufacturers shows that in Mexico and other developing countries, many plants avoid complying with regulations because monitoring and enforcement are sporadic. On the other hand, some plants over-comply because their abatement decisions are strongly affected by extra legal factors and that in developing countries with weak regulation, the carrot of subsidized environmental management training may provide a useful complement to the uncertain stick of conventional enforcement.

Dasgupta *et al*. (1998), further exploring this issue in developing countries conclude that the in developing countries do not have incentives to invest in pollution control because of weak implementation of environmental regulations. They further highlight that environmental regulators in developing countries may explicitly harness those market forces by introducing structured programs of information release pertaining to firms' environmental performance: public disclosure mechanisms in developing countries may be a useful model to consider given limited government enforcement resources.

It is evident in the recent past, not only in the developed countries like the US, the UK and Australia but also in the developing countries in East Asia, that legislation, pressure from key stakeholders and market signals has lead to a surge in the rate of environmental compliance by firms, and as a result, firms are steadily improving their environmental performance (Hettige *et al*., 1996). Nevertheless, there is paucity of literature, especially in the context of developing countries and South

Asia in particular, that explores the impact of regulation as an incentive on the level of adoption of environmental management practices and, to the best knowledge of the authors, the specific case of waste management in the context of Sri Lanka is not addressed to a depth.

However, in a recent attempt to investigate this phenomenon in the context of Sri Lanka, Jayasinghe-Mudalige and Udugama (2011) concluded that agri-food processing firms in Sri Lanka, in general, do not take into account the potential role the government regulation can play as a firm decides to move towards enhanced EMPs. In light of the findings of this study, a key empirical research issue arises, i.e. whether a firm takes private actions to augment environment quality, which is more often than not showing characteristics of a public good, in a situation where it can compensate the less significant losses in the market with relatively higher gains obtained through failures in government policy. Whether, and if so how, the paradigms or perceptions of firms on the potential role of regulation as an incentive for a firm to act on environment quality have changed "overtime", which, however, has not been explored empirically to date using panel data.

The specific objective of this study was, therefore, to examine this empirical research problem; using panel data from agri-food processing sector in Sri Lanka, the role of government regulation for a firm to adopt enhanced solid waste management practices within the firm is explored.

Methodology

Types of SWMPs and Regulatory Incentives of Interest

The Ministry of Environment (and Natural Resources then) [MENR], under the "*National Strategy for Solid Waste Management*" introduces a set of environmental management controls with the characteristics of technology standards for the Sri Lankan food processing industry to minimize the accumulation of solid waste in the firm and reduce industrial pollution, as a whole.

Three such measures introduced under this framework and were the most popular under the 9 recommended practices; (1) "*Sorting of waste based on 3R System*" (i.e. establishment of necessary infrastructure facilities in appropriate places and allocating labor for the purpose); (2) "*Composting*" (i.e. the conversion of solid waste materials into composts, in which the heavy metal composition should be maintained below the recommended standards), and (3) a set of "*Good Manufacturing Practices*" (GMP), were taken into this analysis. 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.

Following Jayasinghe-Mudalige and Udugama (2011), three key factors reflecting different facets of environmental regulation, namely: (1) the existing regulation

(EGR); (2) anticipated regulatory (AGR) frameworks, and (3) the workings of the legal/judiciary system (LBL) of the country were selected, in particular, for the purpose of empirical analysis[2].

In any context, in general, the most obvious stakeholders that influence firms' adoption of environmental practices are various government bodies, which are authorized to exercise coercive power. Existing regulation exerts power on firms towards environmental compliance which could also be threatening or actually impede a company's operations. However, firms can respond to these institutional pressures by adopting different sets of environmental management practices. They can adopt practices of conformance to existing regulations or opt for voluntary management practices.

The other form of regulation is when a firm anticipates regulation or foresees stricter command and control in the future. Some firms have set environmental goals intended to take them beyond compliance with existing environmental regulations, and others build in a "margin of error" which ensures that even when unanticipated fugitive emissions occur, they remain within their legally prescribed emission limits with this anticipation. A major motivation for these firms is to protect environmental reputation by gaining credibility with all other stakeholder groups. This in turn may serve to forestall anticipated regulation for improved environmental performance.

On the other hand, a firm is legally liable when they are financially and legally responsible for their behavior towards the environment. Thus environmental liability directive is based on this 'polluter pays' principle. It requires those operators whose activities pose an imminent threat of environmental damage to take preventive actions, and where such damage has occurred, to remediate it. Environmental liability law can be analyzed in terms of two alternative liability rules: strict liability and negligence. Under strict liability, the polluter is required to compensate harm, irrespective of behavior. Under negligence, the polluter's liability is contingent on a breach of a behavioral standard.

Collection of Data

The database used in Jayasinghe-Mudalige and Udugama (2010), which includes primary data gathered on various aspects related to a firm's performance on environmental quality management from 325 firms in 2008/09 (Stage I), was considered as the sampling framework to select firms for panel data in Stage II.

[3]Visit:*http://www.sandeeonline.org/uploads/documents/publication/937_PUB_WP_60_Udith_Jaysinghe.pdf* or contact the Corresponding Author at: *menukaudugama@gmail.com* to have a copy of the Working Paper published by the South Asian Network for Development & Environmental Economics (SANDEE), which explains the entire procedure associated with identifying these incentives.

Taking into consideration of the nature of firms participated to the Stage I of this study and also the time and budgetary constraints, we decided to limit the sampling framework into the Stage II of this study for 50 percent of firms participated to Stage I (i.e. about 150 – 160 firms). To select the best representative sample of firms to collect panel data, a systematic procedure was followed.

First, it was decided to select firms that can be categorized into one of five sub-sectors, including: processed fruits and vegetables (PFV)], coconut products (COP), essential oils (ESO), non-alcoholic beverages (NAB), and other processed products (OPP). Next, we have contacted the firms participated to Stage I over the phone and were informed about the intention of study, and more specifically, about their contribution to the Stage I and the importance of participation to the Stage II in which each firm's progress on this issue is investigated. For the firms who have "given their consent to participate" in this phone conversation (i.e. about 200 firms), a letter of request for an appointment together with the summary of outcome of Stage I was sent[3].

In selecting the firms to get panel data, attention was paid to maintain a minimum of a two year gap with respect to collection of data from a given firm from Stage I to Stage II. The idea was to give sufficient time for each firm to make managerial decisions by reallocating firm's resource base to come up with appropriate environmental management practices, within or beyond the framework suggested by the Ministry of Environment, to control solid waste generated at the firm and the management and staff associated with environmental quality related aspects in the firm can obtain necessary information and/or undergo training on specific areas of interest (e.g. GMP, ISO 14000 etc.).

The firms were further categorized into various sub samples based on the Province where they are located [i.e., Western (WP), North Western (NW) and Central (CP)]. To support the analysis based on firm-specific characteristics and to be representative to the industry structure observed in Stage I, the classification used in Stage I to reflect firm size was retained, which took into account firm's annual sales value for this purpose, namely: (a) "Small" (Rs. 100,000 – 250,000), and (b) Medium (Rs. 250,000 – 500,000) and (c) "Large" (>Rs. 500,000).

A *face-to-face* personal interview supported by the structured questionnaire [4]which is slightly deviated from the format used in Stage I to accommodate panel data, followed by an inspection of the site for the cases where permission was granted, was carried out with the same person that responded to the Stage I to collect data. In

[3] During the preliminary screening of the firms, 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 and there is no interest in participating.

[4] See, Jayasinghe-Mudalige and Udugama (2011).

cases where the same person was not working in the respective firm (i.e. resign, busy, change position etc.), the top-most executive who possess executive powers to make decisions with respect to environmental quality was contacted.

Like in Stage I, the respondent was asked to report the current situation of the firm with regard to the status of adoption of those SWMPs in concern (i.e. 3R, Composting, GMP) based on four different criteria expressing the level of adoption, namely: (1) "*No plans*" to implement; (2) "*Possesses a plan*" to implement; (3) "*Is in the proces*s" of implementing; and (4) "*Has already adopted*", the particular SWMP in question.

The firms who did not want to participate to Stage II have cited various reasons for non-response, including: the management was busy during the period of contact with his/her day-to-day operations; not interested on this issue anymore, i.e. does not like to explore the current situation of the firm, confidentiality of information, the outcome of Stage I has no direct implications on the firm etc., which were recorded very often as common issues pertaining to collection of data on sensitive issues like environment and food quality in the firms, especially operating in developing countries (Hettige *et al.*, 1996; Pargal and Wheeler, 1996).

Analysis of Data

The data collected from 146 firms by the end of March 2013 were used in this analysis (i.e. 49.9 percent of original sample in Stage I). The database from Stage I was, thus made to order to include panel data (i.e. to match these data from Stage II with that from Stage I). A number of quantitative data analysis techniques, including estimation of Mean Ranks, derivation of an Aggregate Index (ERRI), paired *t*-test and the Chi-square test were employed to analyze data, and is summarized below.

To derive the Mean Rank of each of the three incentives considered in the analysis (i.e. EGR, AGR and LBL) in each stage, First, the "rank" provided by each respondent to these regulatory incentives based on their relative importance for the firm in its decision to adopt those SWMPs was considered. The rankings provided by respondents in both Stage I and Stage II were then used, separately, to derive Mean Rank for each incentive in each stage.

Further, the panel data were used to develop an index – herein referred to as "*Environment Regulation Responsiveness Index*" (ERRI) that can be used to explore extent to which a manager of a firm perceived the importance of each regulatory incentive considered above (i.e. EGR, AGR, LBL), individually and collectively, in firm's attempt to adopt SWMPs recommended; thus, it can be used as a yardstick to signal the changes that took place in perceptions of these incentives overtime (Oppenheim, 1992). The scores provided by respondents on a five-point Likert Scale on each statement pertaining to individual regulatory incentive were subject to

Principle Component Analysis (PCA)[5] to test for their Unidimensionality (Hair *et al*., 2006) and the steps used in this connection were analogous to that used in Jayasinghe-Mudalige and Udugama (2011) to derive the Environment Regulation Responsiveness Index for the first stage of the study[6].

The values of ERR index ranges from 0 – 1, where a value of 1 denotes that a firm perceives the said regulatory incentive to be "absolutely important" for the firm to look into adoption of these SWMPs, while a 0, on the other end, denotes "not at all". Where the set of firms are of concern, it was important to assess whether the three incentives had a varying impact or had a communal effect as a whole on the adoption of the recommended practices which led some firms to adopt while others under the same circumstances did not.

It was also of interest to test the strength of the relationship between adopters and non-adopters which was assumed to vary by firm level characteristics i.e. type, size and vintage of the firm with their decision to adopt the recommended practices**.** To test this phenomenon, the *Chi square Test* was performed. Upon testing for the distribution of indices obtained for these three incentives for both stages, a Pared *t*-test was performed to compare the ERRI of both stages hypothesizing that there is no difference among the degree of perception on the importance of regulatory incentive of each firm over time.

Results and Discussion

Level of Adoption of Recommended SWMPs

The sample comprised of 32% "Large" and 33% "Medium" and 35% "Small" scale firms. With regard to the type of SWMPs adopted by firms in Stage II, it was observed that "Good Manufacturing Practices" has become the most popular practice over time followed by the "3R system" and "Composting". "3R System" which was the most popular in Stage I had lost its popularity to "GMPs" by Stage II (Figure 1). It was evident that firms show a keen interest in adopting these practices over time. "Composting" as a practice shows the least adoption rate. This may be due to the fact that, in comparison to other two practices, this requires relatively higher effort, space and human resources during implementation.

[5] PCA is an interdependence technique stated under the Multivariate Data Analysis techniques that is used commonly to define the underlying structure among a set of variables of an analysis objectively, was employed to test this condition.

[6] The steps are not presented here due to page limitations; thus, the interested readers are directed to follow Jayasinghe-Mudalige and Udugama (2011) for further elaboration of methods used.

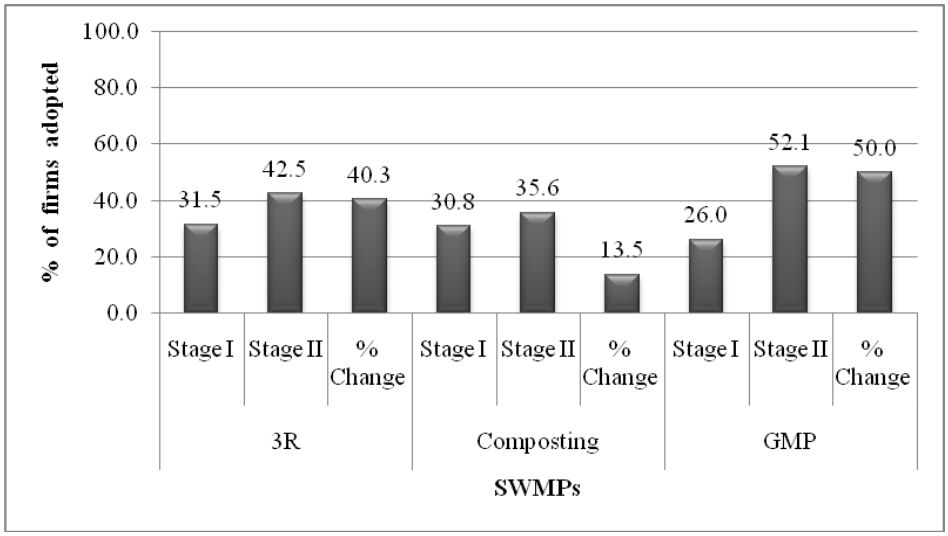

Figure 1: Level of adoption of the most popular SWMPs

Figure 2 shows that the level of adoption of SWMPs has improved overtime, i.e. (Mean, Standard Deviation) (1.25, 1.60) in *Stage I* to (1.86, 1.4) in *Stage II*, suggesting the sector, as a whole, becoming "greener" reflecting repetitively higher levels of adoption. As shown by the left-skewed distribution curve in Figure 2a, during Stage I, about 68 percent of the firms did not possess any of the recommended practices (i.e. non-adopters). However, Figure 2a clearly depicts that this percentage has dropped to 22 percent in Stage II. Further, only 37, 15 and 5 percent of firms adopted one, two or three out of the eight practices recommended, respectively, in Stage I. These percentages, respectively, have been changed to 50, 35 and19 in Stage II creating a shift in the distribution curve to the right. However, it was evident that in Stage II, the firms that adopted more than 4 practices have chosen to operate with lesser number of practices by shifting to the most technically and cost effective and sustainable practices rather than maintaining several different practices in place.

Interestingly, the number of SWMPs adopted by a firm varied to a greater extent vis-à-vis the type of the firm and its size. With regard to firm size, large firms, not surprisingly, tended to adopt a higher number of SWMPs. For example, nearly 32 percent of large firms adopted more than 4 such practices in plant, compared to 50 percent of small firms who did not adopt a single practice in Stage I. By Stage II, an evident increase of 48 percent was shown by the large firms, while the small firms without a single practice in place (i.e. non-adopters) have decreased to 41 percent indicating a move towards higher environmental responsiveness.

The firms that did not adopt any of these practices in Stage I, or in other words indicated zero adoption, were classified into three categories as: (1) in the process of adoption; (2) plan to adopt within three years (i.e. from the point of time in Stage

I), and (3) do not possess plans to adopt within three years time. It was observed that with regard to the adoption of most popular practices in Stage I (i.e. GMP, Composting, 3R system), as a whole, 20 percent of firms belonging to category 3 above in Stage I had moved into the category 1 or 2 by Stage II denoting a positive drive towards adoption (Figure 3).

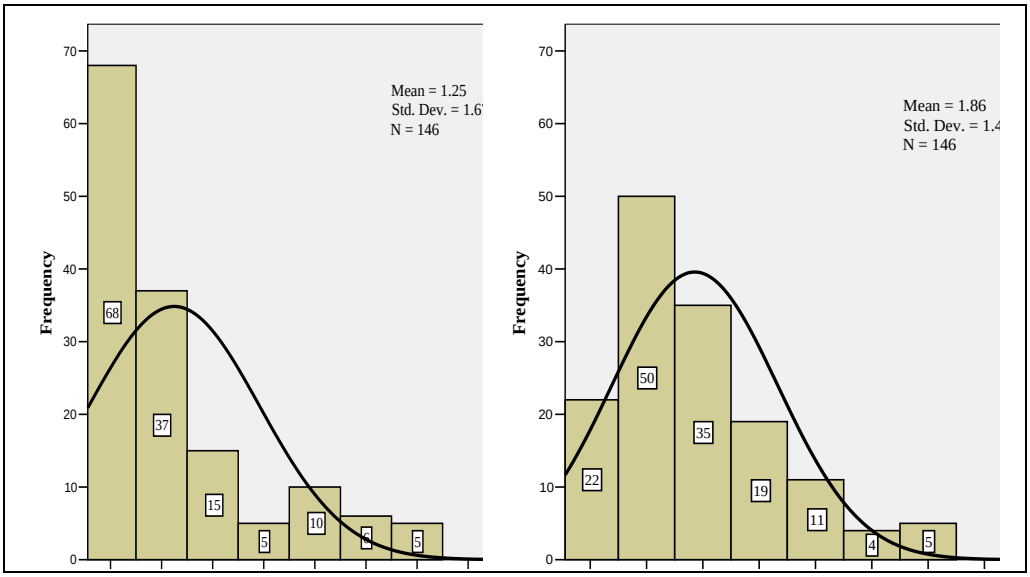

Figure 2a: No. of SWMPs in Stage 1 Figure 2b: No. of SWMPs in Stage II

Figure 2: Number of SWMPs adopted by firms

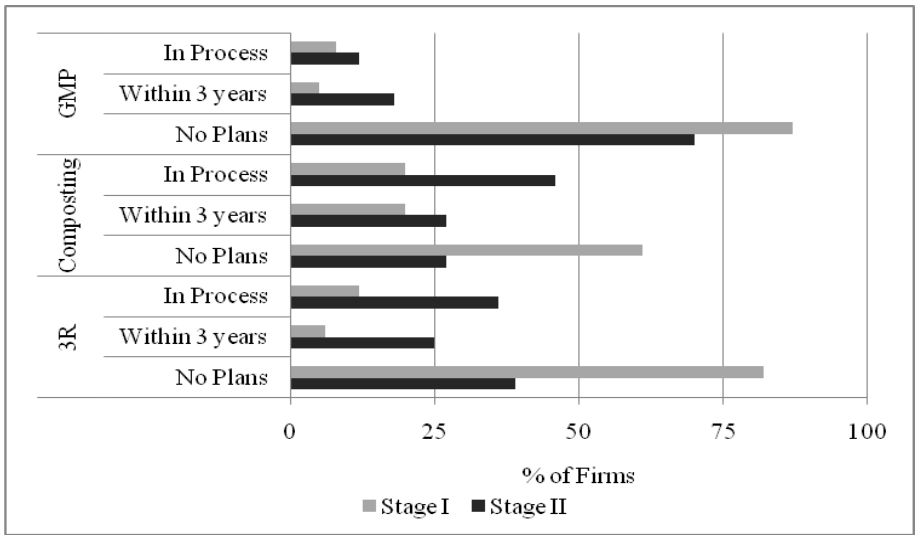

Figure 3: Status of non-adopters of SWMPs

Impact of Regulatory Incentives on the Adoption of SWMPs

The estimates from Mean Ranking highlight that firms over time (Stage I → Stage II), in general, considered that anticipated regulation to be the most important regulatory incentive in Stage I followed by the existing regulation and liability laws. However, this scenario has evidently changed as it comes to the Stage II. Overtime, the firms operate in this sector have perceived that liability laws has a greater importance towards adoption (2.00 → 3.25) over the other two factors, while existing regulation was perceived to be the least important (2.12 → 2.09). This is mainly due to that fact that, at the time of introducing the management practices by the ministerial implementing bodies, the firms may have been under the view that with this recent regulatory emphasis on the environment, the regulations in the future will pose a greater impact on their responsiveness on the environment.

However, with the perceived and evident failures in the regulatory framework, they have been inclined to deem that a financial liability (i.e. may be in the forms of fines, compensation, closure of firms etc.) or rather a liability law would have a greater impact on their behavior as it will make them feel more responsible and liable towards their actions. Simultaneously, certain other firms in the sample felt that a liability law would also have implications on their reputation as well as the profitability of the firm which would hold them responsible for adoption. However, it is noteworthy that the means scores obtained for the responses are generally low implying that regulation as an incentive may not have a considerable impact on the environmental responsive behavior of a firm which needed to be plausible analyzed as we discussed below.

Table 1: Changes in the Mean Rank of ERRI

ERRI	Mean Rank (Relative Position)		% of Change
	Stage I	Stage II	
Existing Regulation	2.12 (2)	2.09 (3)	- 1.41
Anticipated Regulation	2.37 (1)	2.54 (2)	7.17
Liability Laws	2.00 (3)	3.25 (1)	62.5

A more plausible analysis of this fact is rather apparent as we consider the relative changes occurred to the index; ERRI (Figure 4). Although there was no observably distinguishable difference, the highest index values were recorded by firms producing other processed foods. Where scale was concerned, large scale firms perceived the regulatory framework as a whole to be more important to govern compliance in relation to the smaller firms. However, it is evident that irrespective of the size or type of firm, ERRI values lie below the level of 0.5 which implies that although there is a slight improvement in their perception by stage two (stage II values being higher); they only perceive regulation to be slightly more important for

adoption over the years. This increment does not help us make statistical conclusion on the behavioral change guided by their perceptual change.

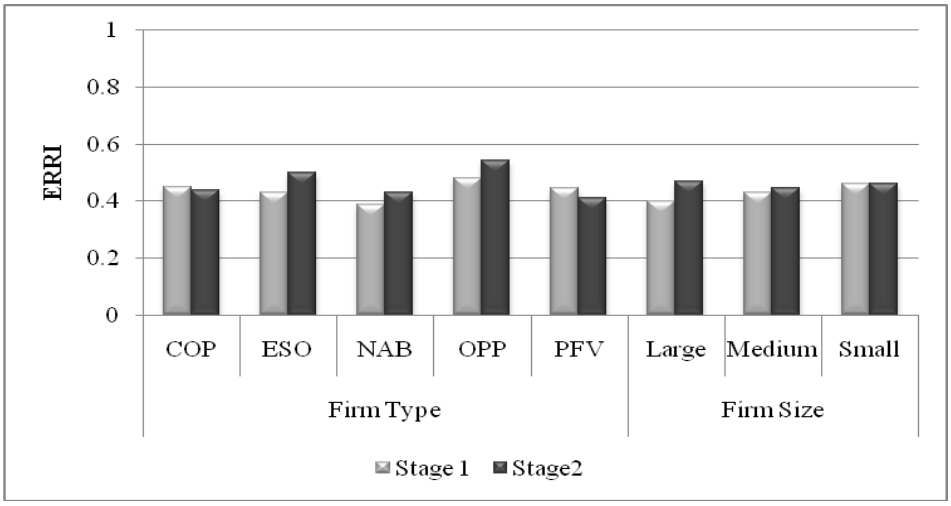

Figure 4: Variation in regulatory incentive index

This justifies out attempt to employ a paired t-test in order evaluate whether there is a significant change in the firms' perception on the impact of the regulatory framework on adoption of environment management practices over the years. The mean value of scores obtained for each statement reflecting regulatory incentives of concern (i.e. mean response values for statement reflecting EGR, AGR and LBL) of both stages were used to conduct a paired *t*-test.

The test was performed on the hypothesis that there is a significant change in the firms' perception on 'the impact of regulation on their adoption of practice' over the years. For example we assumed that there is noticeable difference in the way firms perceived the importance of regulatory incentives which may have changed their behavior to adopt more practices over time. However, the outcome of the test revealed otherwise. Therefore, it was evident that firms' perception on these incentives, reflected by the value of ERRI, showed no significant improvement over time at $\rho = 0.08 > 0.05$.

This draws attention to the fact that firms, as a whole, perceive more on the importance of 'other factors' such as plant level characteristic i.e. firm size (large, medium, small); firm type (COP, ESO,NAB, OPP, PFV) and the number of years a firm has been in operation (Vintage) which may have had a mutually exclusive or combined impact.

It was observed that even after a period of more than two years, and in majority of cases almost three years, despite the fact that there was a considerable level of improved adoption, there was also substantially higher number of non-adopters,

which were categorized as: either in process of adoption, have plans to adopt within three years, or has no plans to adopt. In light of this, it was of our interest to identify if these 'other factors' had any impact on the adoption. Consequently, a Chi-square test was performed to test the relationship between adopters and non-adopters profile, namely type of firm, firm size and vintage (year of establishment) (Table 2).

Table 2: Chi-Square test

		Stage I				Stage II			
Item	**Group**	**Adopt (%)**	**Non-adopt (%)**	**Pea.**	**P-value**	**Adopt (%)**	**Non-adopt (%)**	**Pea.**	**P-value**
Type of firm	COP	39	15	22.2	0.00	31	32	1.0	0.59
	ESO	46	27			42	32		
	NAB	15	58			27	36		
	OPP	14	27			20	26		
	PFV	11	29			16	22		
Firm Size	Large	41	14	29.3	0.00	33	17	6.0	0.19
	Medium	11	18			12	26		
	Small	23	11			19	9%		
Vint	<15	50	59	1.2	0.26	48	50	0.8	0.36
	>15	50	41			52	50		

Noted: Vint = vintage, Adopt = Adopter, Non adopt = Non adopter, Pea. = Pearson Chi-square; * Statistically significant at the 5% level.

The cross tabulation of adopters and non-adopters profiles, from the row percentages highlight the fact that irrespective of time, majority of the ESO firms (46% in Stage I and 42% in Stage II) are adopters followed by the COP firms. As expected it is evident that majority of adopters are the large scale firms (41% in Stage I and 33% in Stage II). However, by Stage II, there is an evident increase in the adoption rate of the medium scale firms showing a tendency to adopt in the future.

Where vintage is of concern, as expected, the more established firms have shown a higher tendency to adopt these practices. The overall group 'type of firm' shows that the observed significant level, P-value of Pearson Chi-square was $P<0.05$ in Stage I. This indicates that there is a significant relationship between type of firm and adoption of the practices. However, by Stage II,it was observed that the adoption did not have a significant relationship with the 'type of firm'.

Pearson Chi-square value for the variables 'size of firm' indicates a significant relationship between the adoption and the firm size in Stage I, while the there was a non significant relationship in Stage II. This test also relates between the experience of firms in terms of vintage and the year of establishment with the adoption. The result reveal that there is no significant relationship of experience of the firm with the adoption in neither of the stages at ($P>0.005$). Hence, we can say that there is no

relationship between adoption of SWMPs with experience of the firm or the years it has been in existence. This draws attention to the fact that although the 'other factors' such as firm level characteristics did have an impact on adoption during Stage I, it was not so by Stage II which directs us to the conclusion that there may also be supplementary factors affecting the adoption of the SWMPs in firms.

Conclusions

The outcome of analysis that looks into the role of regulatory incentives in influencing adoption of SWMPs in the agri-food processing sector in Sri Lanka over the years suggests that firms operate in this sector do not seriously consider the existing government regulatory framework as a promising factor governing their action on environment. The regulation in effect does not seem to motivate adoption of proposed environmental controls. Nevertheless, the weak regulation on environmental quality of the firms does not allow firms to free ride, because current system of liability laws has driven firms to think about potential liabilities associated with non-compliance, which, in turn, to a considerable level steer firms' private action towards adoption of recommended practices. Thus, the *idea* of stricter regulations seems to matter but current regulations seem to be too weak to make a difference.

The results also suggest that a vast majority (> 90%) of firms have "no plans" to adopt any of these practices in the near future citing the financial burden and the lack of information on SWMPs. This decision also highlights the lack of strength of the regulatory framework in stimulating adoption. Further, it could be concluded that the firms in the agri-food processing industry show low levels of responsiveness to regulations irrespective of the firm size/type which does not have a significant effect on the non adoption of SWMPs.

From an economic perspective, regulators would aim to maximize welfare when enforcing a regulation. However, many of these firms avoid complying with environmental regulations because monitoring and enforcement are infrequent. Indeed, the outcome of analysis implies that conventional policy discussion on environmental quality management at the level of firm has been too narrow, focusing only on the recommendation but not on proper implementation aiming environmental performance. Considered period of three years, in an economic sense is not long enough to make a drastic change in human behavior which could be reflect by a complex action as the adoption of environmental control systems.

However, the increased rate of the number of practices which reflects environmental responsiveness underpins a change in behavior, which now can be concluded, is not significantly steered by the regulatory framework as an incentive. This propels us to explore the latent underlying factors of behavior which could be assumed as the prevalence of market-based incentives or the existence of ethical phenomena such as the altruistic behavior of firms.

The role of government, however cannot neglected where the commodity in concern is public in nature which calls for complementary alternatives in designing the appropriate policy tools. In Sri Lanka, regulations may need to be altered at the provincial government level to overcome current shortcomings in the regulatory system. For any regulatory mechanism to be effective, regulators must have a clear understanding of the reasons behind variation in firm level environmental performance, and especially of potential impediments, and their likely effects on pollution control behavior of firms.

It is also possible that the situation would improve if firms were more carefully consulted during the process of establishing regulations and setting standards. The results, overall, , thus, calls attention for a critical revision and adjustments to the policy on environmental quality management at local level incorporating closely monitored, persuasive, targeted programs to promote effective compliance within firms.

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