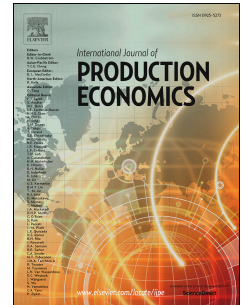


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# **The relationship between downstream environmental logistics practices and performance**

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Transportation and logistics practices conducted downstream in supply chains are often the greatest source of environmental emissions and degradation for companies. The implementation of environmental logistics practices provides a mechanism to tackle this challenge. The natural resource-based view (NRBV) highlights the potential for companies to generate sources of competitive advantage through tackling environmental concerns. It further suggests that engagement with key stakeholders may facilitate the implementation of environmental efforts at the supply chain level. Adopting this perspective, this study considers (i) whether downstream environmental logistics practices improve environmental and cost performance and; (ii) whether engagement with customers supports and enhances the relationship between downstream environmental logistics and performance. Using survey responses collected from 149 food manufacturing companies located within the UK, we find that adoption of downstream environmental logistics practices can generate environmental and cost performance benefits. We also find that the level of performance improvement deriving from these practices may be increased when companies engage with customers to tackle environmental concerns. Considered together, our results suggest that environmental logistics practices provide a mechanism environmental and cost performance improvements

and that these improvements may be enhanced further through engagement with appropriate stakeholders.

**Keywords:** Environmental supply chain management; food; logistics; natural resource-based view

## 1 Introduction

The environmental impact that occurs within internal operations and broader supply chains has emerged as an important consideration for businesses today, generating a general increase in the level of implementation of environmental practices (Kumar et al., 2011; Akin-Ates et al. 2012; Mitra and Datta 2014; Daily et al., 2015; Dubey et al., 2015; Kumar et al. 2015). The increased pressure on companies to manage their environmental impacts and responsibilities prompts questions about the relationship between environmental management efforts and company performance (Dam and Petkova, 2014; Graham and McAdam, 2016). Over the past two decades, the question of whether or not it pays to be green has received substantial research attention (King and Lennox, 2001; Rao and Holt, 2005; Green et al., 2012). Theoretically, the suggestion that environmental efforts may lead to sources of competitive advantage derives from an extension of the resource-based view known as the natural resource-based view (NRBV) (Hart, 1995; Hart and Dowell, 2011). Empirically, a number of studies support this position, confirming that investment in environmental practices at both internal operations and supply chain levels can have a positive impact on company performance (Rao and Holt, 2005; Vachon and Klassen, 2008; Zhu et al., 2012; De Burgos-Jiminez et al., 2014).

This study investigates the link between environmental logistics practices and company performance. Of the studies assessing the relationship between environmental practices and performance outcomes, the vast majority consider the implementation of environmental practices within manufacturing processes (Dey et al., 2012; Marchett et al., 2014). Manufacturing processes across a number of industries generate substantial environmental impact and thus warrant this extensive research attention. However, environmental impact occurs in other areas of the overall production process beyond

manufacturing. Logistics activities, involving the movement and storage of goods throughout the process account for up to 75% of the carbon emissions generated throughout the supply chain (Dey et al., 2011). In particular, logistics practices relating to transportation and distribution conducted downstream in the supply chain, are the source of the highest levels of carbon emissions in some companies and thus warrant further research attention (Goldsby and Stank, 2000; Tang et al., 2015; Velazquez et al., 2015). A number of studies highlight environmentally responsible logistics practices as important within operations and supply chain management research (Wu and Dunn, 1995; Goldsby and Stank, 2000; Gonzalez-Benito and Gonzalez-Benito, 2006; Mejias et al., 2016). While some studies consider the antecedents of environmental logistics practices (Goldsby and Stank, 2000; Gonzalez-Benito and Gonzalez-Benito, 2006; Pazirandeh and Jafari, 2013), no existing studies appear to consider the relationship between logistics practices conducted downstream in the supply chain and company performance.

Drawing upon the literature on environmental operations and supply chain management as well as the arguments of the NRBV, we respond to this important gap by developing and testing a theoretical framework to explain the relationship between environmental logistics practices and company performance. It is becoming more important for studies to move beyond a manufacturing focus to consider environmental challenges emerging from other areas of the supply chain process, such as logistics (Mejias et al., 2016). Further, there is increasing pressure on companies to measure and report their carbon footprint, making high emitting downstream logistics practices a logical area in which to target environmental efforts (Pazirandeh and Jafari, 2013; Tang et al., 2015). As companies are evidently under pressure to manage environmental challenges within their logistics processes, it is helpful to consider the impact that this will have on their performance.

Recent studies highlight the complexity of the relationship between environmental practices and performance, suggesting that there may be other factors that contribute to the successful adoption of these practices (De Burgos-Jiminez et al, 2014; Graham and McAdam, 2016). In other words, performance outcomes may improve further if certain supporting factors are in place during the implementation of environmental practices. The NRBV outlines key supporting factors for the different stages of the process at which implementation of environmental practices might occur (Hart, 1995; Hart and Dowell, 2011). For example, when adopting internal pollution-prevention practices, companies should support this with existing continuous improvement practices in order to obtain the best results. At the supply chain level, engagement with key stakeholders can facilitate more effective implementation of environmental practices, generating greater improvements in performance. There has been some empirical support for a range of internal factors supporting the effective implementation of internal environmental practices (Sarkis et al., 2010; Ronnenberg et al., 2011; Daily et al., 2012; Graham and McAdam, 2016). Fewer studies appear to consider the role of supporting factors in the implementation of environmental practices at the supply chain level. Thus, consistent with the suggestions of the NRBV, we consider the role of stakeholder engagement in supporting the effective implementation of downstream environmental logistics practices (Hart and Dowell, 2011). Customers are key stakeholders downstream in the supply chain and their involvement in environmental practices at this stage of the process is considered in some studies (Vachon and Klassen, 2008; Graham and Potter, 2015). Downstream logistics practices such as the use of reusable pallets or environmentally conscious delivery schedules may require some involvement from customers for their effective adoption. Thus, a willingness from customers to engage with companies in tackling environmental concerns may allow more effective implementation of environmental practices downstream in the supply chain.

Our study addresses two important gaps in the literature. Firstly, the focus on environmental logistics practices broadens understanding of the relationship between environmental practices and performance by targeting a set of practices not previously examined (Dey et al., 2011; Marchett et al., 2014). This is an important consideration for both research and practice, because companies are under ever increasing pressure to account for the environmental impact of their supply chains and the high level of carbon emissions generated through logistics practices. Secondly, identifying the factors that might facilitate the implementation of environmental practices and further enhance potential performance outcomes could help companies to respond to environmental pressures in a way that benefits them.

The food industry is selected as the context for this research due to the unique environmental challenges that it faces, particularly in relation to transportation and logistics (Mahalik and Nambiar 2010; Yakovleva et al., 2012). The perishability of a range of food products creates a need for refrigeration in transport as well as frequent deliveries. Downstream environmental logistics practices related to packaging and transportation are prominent within the food industry (Ubeda et al., 2011). Focusing on this single-industry context permits consideration and control of these industry-specific factors (Vachon and Klassen 2008). In addition, recent studies call for further research to consider environmental issues within the context of the food industry (Accorsi et al. 2014).

The paper begins by developing a theoretical model grounded in the NRBV. This model and its associated hypotheses are tested using Ordinary Least Square (OLS) regression analysis of data from a sample of 149 firms within the UK food industry. Key findings are explored and the paper concludes by considering conceptual and managerial implications.

## **2 Research Framework and Hypotheses**

### ***The Natural Resource-Based View (NRBV)***

The NRBV encourages companies to consider the impact of their operations and supply chains on the natural environment (Hart 1995), suggesting that a proactive operational response to environmental pressures could benefit companies (Chan 2005; Thoumy and Vachon 2012). A proactive environmental approach is indicative of a company's efforts to go beyond compliance with environmental legislation and suggests a level of commitment to improving the environmental performance of its internal operations (Garces-Ayerbe et al., 2012). The NRBV suggests that proactive companies who strategically integrate environmental efforts within their operations and supply chains should expect to obtain benefits from doing so, above and beyond those for companies adopting a more post-hoc approach to environmental management (Hart 1995; Hart and Dowell 2011). At the operations level, a pollution prevention approach is an expression of strategic purposive environmental efforts within the internal production process. This approach seeks to reduce pollution at its source rather than dealing with it in a more reactive manner at the end of the process. Continuous improvement is a key resource facilitating this approach, since it enables firms to reflect on the potential for ongoing preventative action (Grekova et al. 2014).

At the supply chain level, companies can pursue a stewardship approach covering different stages of the overall process, by considering the environmental impact generated throughout the life cycle of the product and/or process (Hart 1995; Wong et al. 2012; Graham and Potter 2015). This comprises activities upstream with suppliers, and internally and downstream with customers. Stakeholder engagement is a key resource in facilitating this extension because the key stakeholders involved at each stage of the process need to cooperate and share relevant information in order for these efforts to achieve their potential (Hart 1995; Grekova et al. 2014).

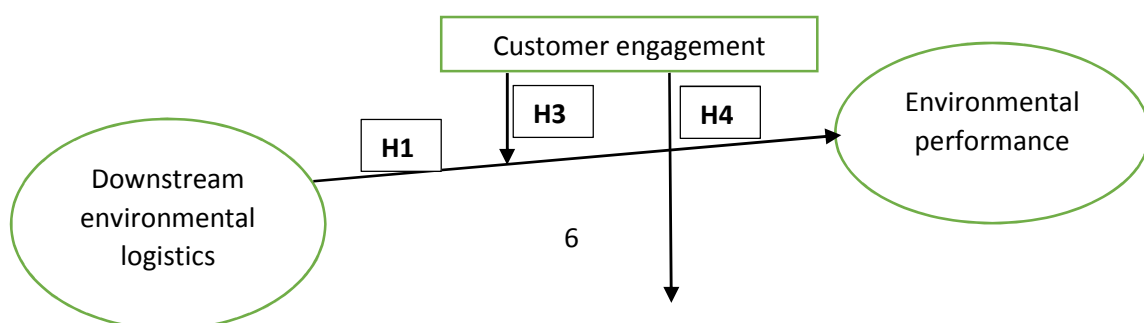


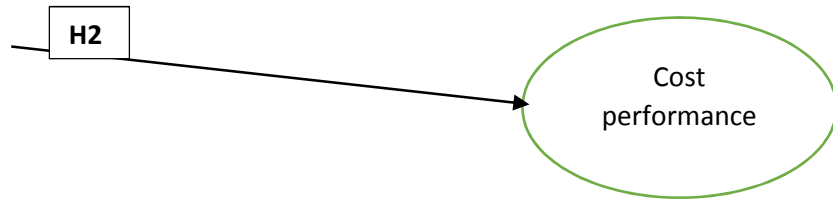
As the focus of this study is on environmental efforts at the supply chain level, with a particular emphasis on downstream environmental logistics, two key propositions of the NRBV relating to a supply chain stewardship approach underpin our theoretical framing. The first proposition is that the implementation of environmental practices at the supply chain level can lead to benefits for companies, such as improved performance. The second proposition is that engagement with key stakeholders can enhance this implementation and generate further performance improvements.

Existing empirical research focusses mainly on the implementation of internal environmental practices and there are calls for studies to consider the propositions of the NRBV with broader reference, i.e. to the supply chain level (Hart and Dowell 2011). Further, the majority of existing studies consider the direct relationship between environmental practices and performance (Rao and Holt, 2005; Vachon and Klassen, 2008; Graham and Potter, 2015) and there are calls for consideration of other factors that might further enhance potential performance outcomes (Zhu et al., 2012; De Burgos-Jiminez et al., 2014). In response to this, we consider the link between downstream environmental logistics practices, customer engagement and performance, as illustrated in Figure 1.

The conceptual framework outlines the hypothesised relationships underpinning this study. It firstly considers the direct relationship between downstream environmental logistics and performance. Following this, it considers the influence of customer engagement on this relationship. The following sections outline details of all the constructs and their hypothesised links.

**Figure 1. Conceptual framework**





### ***Downstream environmental logistics***

The term logistics incorporates a broad range of activities relating to the movement and storage of raw materials, components and finished products along the supply chain (Wu and Dunn 1995). Managing the environmental impact of logistics should be a key concern for companies since transport operations are often the greatest source of environmental degradation (Wu and Dunn 1995; Goldsby and Stank 2000; Pazirandeh and Jafari 2013).

Logistics activities vary according to the stage of the supply chain under consideration. For example, inbound logistics activities conducted upstream include the receipt, storage and movement of raw materials, whereas outbound logistics activities conducted downstream include storing and distributing finished products to customers (Wu and Dunn, 1995). While some studies adopt a broader definition of logistics that incorporates movement and storage from upstream to downstream (Hervani et al., 2005; Gonzalez-Benito and Gonzalez-Benito 2006), others focus more specifically on transportation activities along the supply chain (Pazirandeh and Jafari 2013; Tang et al. 2015; Velazquez et al. 2015).

In this study, we focus on the downstream logistics practices conducted with customers and assess the role of customer engagement in improving performance outcomes from these practices. Recent studies highlight the environmental impact of downstream logistics activities noting a range of potential responses such as, reduced shipping frequency, increased vehicle filling rates and the use of more energy-efficient vehicles (Ubeda et al., 2011; Tang et al. 2015; Velazquez et al. 2015). While all aspects of logistics are important to consider, downstream logistics activities should be a key focus for firms seeking to

proactively manage their environmental impact, due to the high level of carbon emissions generated at this stage (Eng-Larsson and Kohn 2012; Pazirandeh and Jafari, 2013).

### ***Performance outcomes from downstream environmental logistics***

A number of studies generate empirical support for the propositions of the NRBV, advocating a positive link between environmental practices and competitive advantage (Rao and Holt 2005; Vachon and Klassen 2008; Gimenez et al., 2012; Graham and Potter, 2015). The concept of competitive advantage represents a firm's ability to generate superior levels of performance to those of their competitors. Within empirical studies, this translates into a number of different performance dimensions, such as environmental impact, cost, flexibility, delivery and quality (Ronnenberg et al., 2011; Daily et al., 2012). Substantial empirical evidence exists in support of a link between various environmental practices and environmental performance (Pullman et al., 2009; Yang et al. 2010; Zhu et al., 2012; Graham and Potter 2015). Improvements in environmental performance reflect the extent to which environmental practices successfully reduce the negative environmental impacts deriving from the production process (De Burgos-Jiminez et al., 2014). A positive link between environmental practices and environmental performance is evident in the current literature (Vachon and Klassen 2008; Zhu et al., 2012). While this link is supported in relation to manufacturing practices, rather than logistics practices, we expect that this link will exist in the case of downstream environmental logistics practices. Downstream practices relating to transportation and distribution negatively impact on the environment in a number of ways including the generation of energy emissions and streams of waste downstream in supply chains (Gonzalez-Benito and Gonzalez-Benito, 2006; Pazirandeh and Jafari, 2013; Tang et al., 2015). These concerns are particularly prominent within the context of the food industry,

where frequent deliveries of perishable goods occur on an ongoing basis (Soysal et al., 2014). Environmental logistics practices downstream in the supply chain seek to reduce these impacts through the adoption of cleaner transportation methods, less frequent deliveries and more effective management of waste streams (Gonzalez-Benito and Gonzalez-Benito, 2006). We expect that companies adopting these practices will reduce some of these negative environmental impacts and consequently improve their overall environmental performance as reflected in the following hypothesis:

*H1: There is a positive association between downstream environmental logistics practices and environmental performance*

Cost is a critical dimension of performance for all companies, particularly those operating in highly competitive industries such as the food industry (Soysal et al., 2014). A number of studies assess the relationship between environmental practices and cost performance, generating some empirical support for a positive relationship (Christmann, 2000; Rao and Holt, 2005; Vachon and Klassen, 2008; Schoenherr 2012; Hofer et al., 2012; Graham and Potter 2015). The arguments in support of cost improvements deriving from environmental practices suggest that the reduction of waste and emissions can improve the efficiency of processes and reduce costs as a result (Rao and Holt, 2005; Griffith and Bhutto, 2009). Other proponents of this link highlight that even small efforts to reduce the environmental impact of production processes have the potential to improve cost performance and generate sources of competitive advantage (Hart and Ahuja, 1996). Further, Zhu et al. (2012) identify the costs associated with poor environmental performance suggesting that companies can reduce these costs and improve their overall cost performance through the adoption of practices that reduce negative environmental impacts. These studies examine this link in relation to manufacturing

practices implemented internally or at the supply chain level. Logistics practices relating to transportation and distribution not only generate substantial environmental impact but also high costs for a number of companies (Tang et al., 2015; Mejias et al., 2016). We expect that efforts to make these practices more environmentally friendly and efficient may lead to cost reductions for the companies adopting them. For example, more efficient transportation will lead to lower fuel costs as well as lower carbon emissions, potentially resulting in fewer fines (Zhu et al., 2012). While there may be initial investment costs in implementing these practices (Marchett et al., 2014), we expect that their adoption will generate improvements in cost performance similar to those noted in the case of manufacturing practices (Hart and Ahuja, 1996; Rao and Holt, 2005; Griffith and Bhutto, 2009). The following hypothesis reflects this;

*H2: There is a positive association between downstream environmental logistics practices and cost performance*

### ***The moderating influence of customer engagement on performance***

Recent studies highlight the complexity of implementing environmental practices within operations and supply chains suggesting that a range of complementary factors play an important role in this process (Christmann, 2000; Galleazo et al., 2014; Marshall et al., 2015). These factors may influence the extent to which positive performance outcomes are obtained from environmental practices (De Burgos-Jiminez et al., 2014). Thus, studies are moving away from assessing the direct relationship between environmental practices and performance towards consideration of other factors that potentially interact with these practices to generate higher levels of improvement (Zhu and Sarkis, 2007; Graham and McAdam, 2016). Christmann (2000) suggests that consideration of the moderating role of complementary

factors should shed further light on the relationship between environmental practices and competitive advantage. A number of studies examine the presence of moderating factors in relation to the implementation of practices and the performance outcomes generated from these practices (Zhu and Sarkis, 2007; Blome et al., 2014; Marshall et al., 2015). A broad array of moderating factors is presented in the extant literature ranging from internal integration (Williams et al., 2013), to entrepreneurial orientation (Marshall et al., 2015), to existing quality management capabilities (Zhu and Sarkis, 2004), to institutional pressures (Zhu and Sarkis, 2007; Liu et al., 2010). Considered together, these studies suggest that the presence of appropriate complementary factors may support the implementation of environmental practices, leading to greater improvements in performance outcomes. Thus, the interaction of environmental practices with complementary factors leads to higher levels of improvement than the isolated implementation of these practices.

There are calls for more studies to develop understanding of the complex relationship between environmental practices and performance through examining potential complementary factors (Christmann, 2000; Hart and Dowell, 2011). The NRBV suggests that engagement with key stakeholders plays an important complementary role in the implementation of environmental practices in the supply chain (Hart, 1995; Hart and Dowell, 2011). Suppliers and customers represent key stakeholder groups within the supply chain and a number of studies consider the potential for these stakeholders to enhance the implementation of practices within supply chain management research (Handfield et al. 1999; Johnsen et al. 2006). The potential for sharing resources and capabilities through stakeholder engagement may complement or enhance a company's environmental efforts (Vachon and Klassen, 2008). Further, environmental supply chain practices may require some participation from key stakeholders in order to be implemented effectively (Hart, 1995; Hart and Dowell, 2011). For example, practices implemented upstream in the supply chain may require a level

of engagement and cooperation from suppliers in order to be implemented effectively (Bowen et al., 2001). If suppliers are not engaged with these upstream efforts, the focal company may need to invest more time and resources in bringing them on board with these efforts, creating a detrimental impact on performance.

While other studies suggest that stakeholder engagement and environmental practices may be important direct antecedents to improved performance (Vachon and Klassen, 2008; Hofer et al., 2012), no studies to date appear to consider the potential complementary relationship between these different factors in improving company performance. While it is possible to argue that each practice may influence performance directly, without necessarily requiring the other to do so, we argue that engagement with key stakeholders plays an important complementary role in the implementation of environmental practices at the supply chain level. If key stakeholders are not supportive of practices that potentially require their cooperation and support, this could hinder the ability of the focal company to generate potential performance improvements from these practices (Liu et al., 2010). On the other hand, if the key stakeholders are engaging and supportive, this may facilitate the generation of more positive performance outcomes as their combined efforts may lead to further success than their isolated efforts (Hart and Dowell, 2011).

The focus of this study is on downstream environmental logistics practices which generally relate to the distribution of finished products to customers (Hervani et al. 2005). Customers play a particularly important and influential role in the context of the food industry (Mena et al., 2014); thus, we consider them as the key stakeholder group in this study. Customer collaboration and monitoring represent measures of customer engagement, as they reflect the extent to which the customer participates in the implementation of environmental practices, either through taking part in the implementation process or monitoring the progress of the environmental practices within the focal firm (Vachon and Klassen 2008; Marchett et

al., 2014). Both suggest a level of interest and engagement with environmental practices, indicating that environmental efforts are important to this key stakeholder group. Downstream environmental logistics activities may involve efforts to reduce delivery days or adopt more energy efficient modes of transport (Ubeda et al. 2011; Tang et al. 2015; Velazquez et al. 2015), which influence the level of customer service provided by the focal firm and require a certain amount of customer support. Further, to facilitate the recycling and reuse of waste streams and packaging, customers may need to participate in the delivery process by returning delivery crates, packaging or food waste to the company. Customers may have their own experiences and capabilities with environmental practices that could help the company to implement these practices more effectively (Vachon and Klassen, 2008; Hart and Dowell, 2011). The customers of food manufacturing companies tend to be retailers who are also under increasing pressure to manage the environmental impact of their supply chains (Mena et al., 2014). Environmental impacts from packaging and transport are two key areas that all actors in food supply chains are under pressure to improve (Soysal et al., 2014); hence, customers may be willing to engage with food manufacturers in the implementation of downstream logistics practices that target these key areas.

Engagement with customers may enhance the potential for downstream environmental logistics practices to improve performance, because their resources and expertise should support effective implementation (Vachon and Klassen, 2008; Martinsen and Bjorkland, 2012). Within the context of the UK food industry where retailers are known to exert substantial power and influence over food manufacturing companies, their engagement with downstream environmental practices may be particularly important (Hingley, 2005; Hingley et al., 2015). If the retailers are not on board with environmental logistics practices that promote full van loads and potentially reduce the number of delivery days, it may be more difficult for focal companies to implement these changes. Thus, higher levels of customer



engagement may facilitate more extensive implementation of downstream environmental practices which may be conducive to higher levels of performance improvements from these practices. On the other hand, lower levels of customer engagement may be indicative of a resistance towards the implementation of downstream environmental practices that might hinder potential performance improvements. Therefore, customer engagement may be a complementary factor in the implementation of downstream environmental practices that enables companies to improve potential performance outcomes to a greater extent. This is reflected in the following hypotheses;

*H3 The positive relationship between downstream environmental logistics and environmental performance is stronger in the presence of high levels of customer environmental engagement.*

*H4 The positive relationship between downstream environmental logistics and environmental performance is stronger in the presence of high levels of customer environmental engagement.*

### **3 Research Methodology**

#### ***Sample frame***

A sample of 1200 firms in the UK food industry (within the Standard Industrial Classification (SIC) DA 15, which includes the manufacture of food products and beverages) was compiled from a dataset purchased from William Reed media. Consistent with other studies adopting a single-country, single-industry focus (Bourlakis et al. 2014; Grekova et al. 2014; Mena et al. 2014), our focus on the UK food industry allows the control of country- and industry-specific factors that may influence results within this unique and complex context (Vachon and

Klassen 2008; Mahalik and Nambiar 2010; Yakovleva, Sarkis, and Sloan 2012). Data collection and analysis took place during 2011-2012. We developed and pilot tested a mail questionnaire in accordance with guidelines from Dillman (2007). Six semi-structured interviews were conducted with environmental and operations managers in food processing firms to facilitate the development and refinement of the survey instrument. Following this, we conducted pilot tests with six further managers and six senior academics to ensure the quality of the final instrument prior to data collection (Fowler 1993; Drucker 2000). Following this, we distributed the final survey in three waves, following up with phone calls to encourage further responses (Forza 2002). A total of 149 responses were received, generating a response rate of 12.4%, consistent with similar studies in this area of research (Paulraj 2011).

The data were subjected to standard statistical tests for non-response bias prior to analysis. Firstly, a comparison of early and late responses was conducted using bivariate correlations (Armstrong and Overton 1977; Etter and Perneger 1997). In addition to this, a comparison of sample and population information was conducted as a test of non-response (Paulraj, Jayaraman and Blome 2014). For this, information on firm size (number of employees) and sub-industry group was collected from a number of companies on the list of non-respondents. Group comparison tests between the sample mean values and the population mean values suggest that they are not significantly different at  $p < .001$ .

A question on the level of knowledge in relation to environmental practices within the firm was included at the end of the survey in order to ensure respondents' knowledgeability about the issues under investigation. An average knowledge score of 84.2% generated confidence that the majority of the respondents were in a good position to answer the questions asked. Further details of the respondent and sample characteristics are presented in Table 1.

**Table 1 Sample and Respondent characteristics**

	Frequency	Percentage
<b><i>Respondent job title</i></b>		
Production Manager	13	8.7
Operations Manager	24	16.1
Environmental Manager	14	9.4
Managing Director	16	10.7
General Manager	7	4.7
Technical Manager	17	11.4
Site/Plant/Factory Manager	14	9.4
Other	44	29.5
<i>Total</i>	149	100
<b><i>Sub-industry group</i></b>		
Processed food	31	20.8
Beverages	27	18.1
Meat, Poultry and fish	26	17.4
Dairy products	21	14.1
Other	44	29.6
<i>Total</i>	149	100
<b><i>Number of employees</i></b>		
<i>Under 50</i>	36	24.2
<i>51-100</i>	29	19.5
<i>101-250</i>	50	33.6
<i>251-500</i>	21	14.1
<i>501-1000</i>	6	4.0
<i>Over 1000</i>	6	4.0
<i>Missing</i>	1	0.6
<i>Total</i>	149	100

The constructs in the study are assessed using multi-item scales, as outlined in Table 2. Each item is measured on a 7-point Likert scale. Where possible, previously validated measures are used; however, due to the emergent nature of this area of research, some of the measures were newly developed or adapted on the basis of insight from other sources. The measure for downstream environmental logistics was adapted from a pre-existing measure developed by Gonzalez-Benito and Gonzalez-Benito (2006) and contains four items which assess the extent to which the sample companies implement environmental logistics practices downstream in their supply chain. The measure for customer engagement contains three items adapted from pre-existing measures developed by Vachon and Klassen (2008). This measure assesses the extent to which the sample companies engage with their customers in environmental

management efforts. The performance scales assess the extent to which the sample companies have noted improvements in environmental performance and cost performance as a result of environmental efforts. The environmental performance measure contains five items and was newly developed for the study based on studies considering the link between environmental practices and performance in the context of the food industry (Maloni and Brown, 2006; Pullman et al., 2009). The cost performance measure contains four items adapted from a pre-existing measure developed by Vachon and Klassen (2008).

### ***Reliability and Validity***

To determine the overall effectiveness of the items used to measure each of the constructs, exploratory factor analysis (EFA) using orthogonal rotation was conducted on the four scales (after Hair et al. 2006). To test for discriminant validity, the correlation coefficients for all of the items were inspected in a correlation matrix. The coefficients for items measuring different constructs were low, providing preliminary support for discriminant validity. To further confirm this, EFA was used to assess the extent to which the various items loaded onto the construct they were intended to measure. To assess the significance and strength of relationships among the items, Bartlett's test for sphericity and Kaiser Meyer Olkin's (KMO) test were conducted on each of the scales. The KMO score (above 0.8) and the significance of the Bartlett's test of sphericity ( $p < .001$ ) suggests that the items are suitable for factor analysis. A four factor solution is suggested in the rotation with a high level of variance explained (>69%) and eigenvalues above 1 (see Table 2), providing further support for discriminant validity. All loadings were statistically significant and above the recommended level of .60, suggesting that convergence validity was also achieved. Scree plot diagrams were also inspected, providing further confirmation of a four-factor solution. Cronbach Alpha scores

were also calculated for each of the variables to confirm their reliability as measures. These scores, displayed in brackets in Table 4, all exceeded 0.70, indicating that reliability requirements were met.

**Table 2 Exploratory factor item loadings**

Items	1	2	3	4
<i>Customer engagement</i>				
Our major customers give us environmental targets to meet	.85			
Our major customers monitor out environmental management practices	.85			
Our major customers provide training on implementing environmental management practices	.75			
<i>Environmental Performance</i>				
Reduced raw materials usage		.79		
Reduced carbon dioxide emissions		.73		
Decrease in consumption of hazardous/harmful/toxic materials		.63		
Reduced water use by factories		.81		
Reduced energy usage		.83		
<i>Cost Performance</i>				
Total product costs			.91	
Production costs			.89	
Transportation costs			.79	
Material input costs			.71	
<i>Downstream environmental logistics</i>				
Adoption of cleaner transportation methods				.69
The use of recyclable/reusable packaging in distribution				.80
Responsible disposal of waste and residues from the distribution process				.84
A distribution system that enables recycling and reuse of waste				.80
<b>Variance Explained</b>	32.74	15.52	11.92	9.10
<b>Eigenvalues</b>	5.24	2.48	1.91	1.46

Prior to testing the hypotheses, confirmatory factor analysis (CFA) was performed on the 16 items comprising the four measurement scales using AMOS version 22. The factor loadings for the four factor model are outlined in Table 3. All items were above the threshold of 0.5 and retained for further analysis. The  $\chi^2$ , degrees of freedom and fit indices were  $\chi^2 = 157.581$ , degrees of freedom = 98, comparative fit index (CFI) = 0.947, Tucker-Lewis index (TLI) = 0.935, standardised root mean square residual (SRMR) = 0.069, and the root mean square error of approximation (RMSEA) = 0.064. All the fit indices indicate that the model fitted the data well.

Competing model variations were also tested to confirm that the proposed four factor solution was the best fit for the data. The second CFA model combined the two practice variables, downstream environmental logistics and customer engagement, into one practice construct, suggesting a two factor solution. The third CFA model combined the two performance variables, environmental impact and cost, into one performance construct, suggesting a three factor solution. The fourth CFA model combined both the practice and performance variables into a two factor solution. The final CFA model tested a one factor solution where all 16 items were loaded onto one factor. The model fit statistics for the five CFA models are outlined in Table 4 and indicate that the proposed four factor solution fits the data best. The means, standard deviations, correlations and reliabilities of the four scales comprising the framework appear in Table 4.

**Table 3 Confirmatory factor-item loadings**

Statement	Loading
<i>Downstream Environmental Logistics</i>	
Adoption of cleaner transportation methods	0.62
The use of recyclable/reusable packaging in distribution	0.73
Responsible disposal of waste and residues from the distribution process	0.81
A distribution system that enables recycling and reuse of waste	0.85
<i>Customer engagement</i>	
Our major customers give us environmental targets to meet	0.91
Our major customers monitor our environmental management practices	0.77
Our major customers provide training on implementing environmental management practices	0.56
<i>Environmental performance</i>	
Reduced raw materials usage	0.82
Reduced carbon dioxide emissions	0.72
Decrease of consumption of hazardous/harmful/toxic materials	0.71
Reduced water use by factories	0.66
Reduced energy usage	0.77
<i>Cost performance</i>	
Reduced total product costs	0.63
Reduced production costs	0.91
Reduced transportation costs	0.72
Reduced material input costs	0.91

**Table 4 Model fit statistics**

<i>Model</i>	$\chi^2$	<i>df</i>	$\Delta \chi^2$	<i>CFI</i>	<i>TLI</i>	<i>RMSEA</i>	<i>SRMR</i>
1. Hypothesized Four Factor Model	157.581	98	-	.947	.935	.064	.069
2. Three Factor Model: Practices combining downstream logistics and customer engagement	272.199	101	114.618***	.846	.818	.107	.093
3. Three Factor Model: Performance combining environmental and cost performance	451.967	116	294.386***	.709	.659	.110	.140
4. Two Factor Model: Practices combined (downstream logistics and customer engagement) and performance combined (environmental and cost)	538.756	103	381.175***	.609	.545	.169	.130
5. One Factor Model	753.441	119	595.86***	.451	.372	.151	.190

N= 149;  $\chi^2$  = Chi-square discrepancy; df = degrees of freedom;  $\Delta \chi^2$  = difference in chi-square; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; RMSEA = Root Mean-Square Error of Approximation; SRMR = Standardized Root Mean Square Residual

**Table 5 - Means, standard deviations, correlations and reliabilities among variables**

No.	Variable	Mean	S.D	1	2	3	4
1	Downstream environmental logistics	4.62	1.47	(0.84)			
2	Customer engagement	2.79	1.46	0.36**	(0.79)		
3	Environmental performance	4.42	1.41	0.43**	0.19*	(0.85)	
4	Cost performance	4.43	0.89	0.26**	0.06	0.34**	(0.87)

Note: \*\*\* p<0.01, \*\* p<0.05, \*p<.10 Cronbach Alpha scores in brackets.

#### 4 Data analysis and results

Ordinary Least Square (OLS) regression analysis is used to test the model and hypotheses. Normality, linearity, and homoscedasticity are assessed using residual diagnostics tests, univariate and graphical analysis. The presence of multicollinearity is assessed using variance Inflation Factor (VIF) scores. These preliminary analyses indicate that the data meet the

requirements for OLS regression. However, there is considerable debate in the statistical and methodological literature around the advantages and disadvantages of analysing Likert scales (as opposed to single Likert items) as continuous variables, with some arguing that it is appropriate under certain conditions (Carifo and Perla, 2008; Norman, 2010), and others that it is not (Jamison, 2004). Therefore, in addition to testing for violations of the OLS assumptions, additional categorical regression models were developed to examine the robustness of our results. Due to the small sample size, the mean values in the Likert scale were rounded into seven ordered categories and original logistic regression applied. However, three of the six models violated the test of parallel lines, and due to the small sample size multinomial regression was not possible. We therefore collapsed the seven point scale into two categories and built logistic regression models as a test of robustness. The results of these tests did not reveal any evidence that would lead us to question the results of the OLS models. Further robustness checks were carried out by building models by industry and firm size, neither of which resulted in changes to the overall conclusions.

Two regression models were run to assess the relationship between environmental logistics and performance. Environmental performance constitutes the dependent variable in the first regression model and cost performance in the second. Five control variables are included in the first step of each of the regression models. These include firm size (i.e. the natural logarithm of the number of employees), four industry variables, namely, processed food, beverage, meat and dairy (i.e. the dichotomous variables indicating the sub-industry group from which the firm derives, based on four-digit SIC codes). The direct effect of downstream environmental logistics on performance is assessed in step two of each model. Finally, the interaction effect between environmental logistics and customer engagement is regressed on the performance outcomes at step three in each model. The results for both regression models are displayed in Table 6.



**Table 6 – Performance outcomes from downstream environmental logistics. Direct and moderating effects.**

	ENVIRONMENTAL PERFORMANCE			COST PERFORMANCE		
	STEP 1	STEP 2	STEP 3	STEP 1	STEP 2	STEP 3
<i>Control Variables:</i>						
Firm Size	.34***	.27***	.28***	.00	-.04	-.02
Process Food Industry	.18*	.16	.15	-.01	-.03	-.04
Beverages Industry	.19*	.26**	.24*	.03	.06	.04
Meat Industry	.06	.09	.09	.02	.04	.05
Dairy Industry	.16*	.20*	.21*	-.05	-.01	-.01
<i>Direct Effects:</i>						
Downstream environmental logistics		.41***	.46***		.28***	.38***
Customer engagement		.03	.01		-.01	-.06
<i>Moderating Effects:</i>						
Downstream environmental logistics x Customer engagement			.15*			.26***
(Constant)	2.22***	2.49***	2.38***	4.43***	4.40***	4.47***
▲R <sup>2</sup>	.15	.17	.02	.00	.08	.06
▲F	5.06***	17.12***	4.19*	.13	5.77**	9.69**
Overall R <sup>2</sup>	.15	.32	.34	.00	.08	.14
Adjusted R <sup>2</sup>	.12	.28	.30	-.03	.03	.09
Overall model F	5.06***	9.32***	8.87***	.13	1.74*	2.83**
N	149	149	149	149	149	149

Standardized regression coefficients are shown. Note: \*\*\* p&lt;0.01, \*\* p&lt;.05, \*p&lt;.10

***The direct relationship between downstream environmental logistics and performance***

Step 1 in the environmental performance model considers the influence of the control variables on environmental performance. Four of the controls, namely, firm size, processed food industry, beverages industry and dairy industry appear to be significant, explaining around 15% of the variance in environmental performance. The inclusion of downstream environmental logistics in step 2 generates a positive and significant increase in the variance explained (change in  $R^2 = 17\%$ ; the change in F statistic is 17.12,  $p < 0.001$ ). The effect of downstream environmental logistics is positive and highly significant ( $\beta = .41$ ,  $p < 0.001$ ), generating support for Hypothesis 1.

Results for the regression model assessing the links between downstream environmental logistics and cost performance are also displayed in Table 6. None of the controls appear to be statistically significant across any of the models, indicating that they have no influence on cost performance outcomes. Furthermore, the variance explained in the dependent variable by the control variables in step 1 is 0%, providing further support for their limited impact. The inclusion of downstream environmental logistics in step 2 generates a positive and significant increase in the variance explained (change in  $R^2 = 8\%$ ; the change in F statistic is 5.77,  $p < 0.01$ ). The effect of downstream environmental logistics is positive and highly significant ( $\beta = .28$ ,  $p < 0.001$ ), generating support for Hypothesis 2. It is worth noting that the overall  $R^2$  for the cost performance model is quite low relative to the environmental performance model. This may be due to the lack of contribution from the control variables which do not appear to have any significant impact on the cost performance outcome. In the case of environmental performance, inclusion of the control variables generates an increase in variance of 15% in the first step, generating a higher overall  $R^2$  for the model, relative to the cost performance model. Graphical analysis provides further support for the hypotheses 1 and 2.

***The interaction effect of downstream environmental logistics and customer engagement on performance***

The interaction effect of downstream environmental logistics and customer engagement is considered in step 3 of each model. An interaction effect is evident when the coefficient of the interaction term is significant and the value of  $R^2$  increases (Danese and Romano 2013). In the case of environmental performance, inclusion of the interaction term in step 3 generates a positive and significant increase in the variance explained (change in  $R^2 = 2\%$ ; the change in F statistic is 4.19,  $p < 0.05$ ). The effect of the interaction term is positive and significant ( $\beta = .15$ ,  $p < 0.05$ ), generating support for Hypothesis 3.

Where cost performance constitutes the outcome, inclusion of the interaction term in step 3 generates a positive and significant increase in the variance explained (change in  $R^2 = 6\%$ ; the change in F statistic is 6.69,  $p < 0.01$ ). Again, the effect of the interaction term is positive and highly significant ( $\beta = .26$ ,  $p < 0.001$ ), generating support for Hypothesis 4.

To further assess the existence of the interaction effects, simple slope analyses are conducted in accordance with guidelines from Dawson and Richter (2006). The standard deviation of the moderator is used to assess the influence of the moderator at high and low levels of the independent variable (Aiken and West 1991). Firstly, the significant interaction between downstream environmental logistics and customer engagement, regressed on environmental performance is examined. To calculate the value for high levels of integration, one standard deviation (1.46) is added to the mean (0) giving a value of +1.46 to be included in the simple slopes calculation, whilst for low levels of customer engagement this same value is subtracted from the mean, giving a value of -1.46. A significant  $t$ -value ( $b = 4.19$ ,  $p < 0.001$ ) is indicative of a moderating effect when levels of customer engagement are high. This provides further support for Hypothesis 3. The same steps were followed in assessing the interaction effect in relation to cost performance. Again, a significant  $t$ -value ( $b = 5.51$ ,  $p <$

0.001) provides confirmation for an interaction effect between downstream environmental logistics and customer engagement when regressed on cost performance. This provides further support for Hypothesis 4.

## 5 Discussion

Adopting the NRBV as a theoretical lens, this study considers the relationship between environmental practices and performance outcomes. Empirical support is generated for all four hypotheses, providing support for the conceptual framework and its underpinning propositions. The support for a positive association between downstream environmental logistics and environmental performance (Hypothesis 1) is consistent with the existing body of research, suggesting that environmental performance improvements derive from a range of environmental practices implemented within company operations and their broader supply chains (Vachon and Klassen 2008; Pullman et al., 2009; Yang et al. 2010; Zhu et al., 2012). Hypothesis 2, suggesting a positive association between downstream logistics and cost performance, is also supported by the results. Empirical support for the link between environmental practices and cost performance has not been as extensive in the extant literature as support for links with environmental performance. The mixed results in some studies suggest that cost performance improvements may be derived from some environmental practices, but not all (Vachon and Klassen, 2008; Pullman et al., 2009; Wong et al., 2012; Graham and Potter, 2015). Our study adds a novel dimension to this existing research base by focussing on logistics practices as opposed to manufacturing practices which have been the primary focus of environmental research to date. Our results suggest that the implementation of environmental logistics practices may be conducive to improvements in cost performance.

Considered together, these results provide support for one of the key propositions of the NRBV underpinning this study, namely, that environmental practices can generate sources of competitive advantage through improved performance (Hart, 1995; Hart and Dowell, 2011). While a number of existing studies already support this proposition (Rao and Holt, 2005; Vachon and Klassen, 2008; Schoenherr, 2012; Hofer et al., 2012), our study is novel in its application of this proposition to the underexplored context of logistics practices. This is an important consideration, due to the high environmental impact of downstream logistics practices within a number of industries and the pressure on companies to reduce carbon emissions (Gondivan et al. 2014; Tang et al. 2015; Velazquez et al. 2015).

Another novel aspect of the study is consideration of the underexplored NRBV proposition relating to the importance of stakeholder engagement. While some studies consider the direct influence of environmental practices conducted with key stakeholders (Vachon and Klassen, 2008; Green et al., 2012; Zailani et al., 2012), none appear to consider the potential for this engagement to moderate or enhance the implementation of environmental practices. This is an important consideration as the relationship between practices and performance is notably complex and there are calls for studies to move towards consideration of moderating or mediating factors that might influence this relationship (Christmann, 2000; López-Gamero et al., 2009; De Burgos-Gimenez et al., 2014). Conceptually, the importance of engagement with key stakeholders during the implementation of environmental supply chain practices is implied in the literature (Hart, 1995; Hart and Dowell, 2011; Blome et al., 2014); nevertheless, empirical testing of is limited.

Our results generate support for the moderating effect of customer engagement on the relationship between environmental practices and performance (Hypotheses 3 and 4). This suggests that greater improvements in environmental and cost performance occur when

customers are engaged in the process of implementing downstream environmental logistics practices. Environmental and cost performance are both important outcomes for food manufacturing companies. Environmental concerns have increased in prominence within this context as a result of pressures from a range of different stakeholders to measure and assess the environmental impact of food supply chains (Mahalik and Nambiar 2010; Yakovleva et al., 2012). As downstream logistics and transportation is oft considered to be the stage of the supply chain where the highest level of environmental impact occurs, it is helpful to understand the complementary factors that might lead to further environmental improvements (Goldsby and Stank, 2000; Tang et al., 2015; Velazquez et al., 2015). Further, improving cost performance is always high on the agenda of food manufacturing companies due to the highly competitive environment in which they operate (Roth et al., 2008; Piramuthu et al., 2013). Therefore, understanding complementary factors that might facilitate further cost performance improvements is also very useful for companies in the food supply chain.

Considered together, these findings highlight the potential for engagement with customers to enable companies to generate more substantial performance improvements when implementing environmental practices downstream in the supply chain. This is an important consideration for firms seeking to improve their performance through environmental management, since a lack of engagement with key parties may hinder the extent to which positive performance outcomes can be achieved. In the case of downstream environmental logistics, any changes to the packaging or distribution of products may affect the level of customer service. If customers are not on board and engaged with environmental efforts, the company may find it more difficult to implement these practices in an effective and beneficial way. Blome et al. (2014) highlight the importance of aligning upstream and downstream efforts with suppliers and customers in order to facilitate performance improvements. Greater engagement with customers may facilitate the coordination and alignment of environmental

efforts downstream, which ultimately should lead to their more effective implementation (Zhu et al., 2012).

### ***Theoretical contributions***

Our study contributes to the development of the NRBV as a theoretical perspective by providing support for two of its key propositions. Firstly, there is strong support for a relationship between downstream environmental logistics and performance, which generates a novel contribution by extending the application of the NRBV to the area of logistics. Secondly, our study is among the first to consider the moderating effect of stakeholder engagement on the relationship between environmental practices and performance. Calls have been made for studies to move beyond consideration of the direct link between environmental practices and performance towards consideration of other supporting or complementary factors that might enhance this relationship (Hart and Dowell, 2011). While some studies consider factors that might complement the implementation of internal environmental practices (Sarkis et al., 2010; Daily et al., 2012; Graham and McAdam, 2016), we are not aware of any studies that consider these factors in the implementation of environmental practices at the supply chain level. Thus, our study makes a novel contribution in this regard.

### ***Managerial implications***

Some interesting insights for managers can also be derived from our results. Firstly, it is evident that environmental logistics practices may generate improvements in both environmental and cost performance for companies. This is important for managers, particularly in the food industry, who are under pressure to reduce their carbon emissions from transportation. It will be useful for them to know that it is possible to do this in a way that may benefit their firms in relation to cost performance. The results suggest that

engagement with customers plays an important role in generating performance improvements from downstream practices. This presents an interesting and important insight for managers as it suggests that optimal performance benefits might not be obtained in the absence of engagement with key stakeholders. Managers should seek to identify customers who are willing to engage with them in tackling environmental concerns. Through doing so, they may be able to extract some knowledge or expertise that will help their own environmental efforts. Further, retailers in the food industry are coming under increasing pressure to measure and manage the carbon footprints in their supply chains (SBM, 2010). As transportation and logistics present one of the biggest challenges in this regard, customers may be more willing and open to engaging with efforts to reduce carbon emissions. Thus, there may be a strong incentive for them to engage more with food manufacturers in tackling environmental concerns and to support their efforts. Our results suggest that this may be beneficial for food companies in two ways. Firstly, environmental performance may be improved further with this engagement enabling companies to respond in a positive way to the ever increasing environmental pressures they face. Secondly, there may be cost improvements inherent in these joint efforts which enables them to respond to constant cost related pressures facing their industry.

### ***Limitations and future research directions***

This study contains some limitations that should be noted. Firstly, the data are cross-sectional which restricts the ability to account for the timing of practices. It may be the case that the timing of practices influences performance and this is something that future studies could consider through the collection of longitudinal data. Further, the data have been collected from single respondents, namely, the manufacturing companies. Due to the relational aspect of some of the variables considered, namely, customer engagement, it may be informative to



have data from customers as well, to identify how this engagement benefits them. Future studies might consider this engagement and its influence on performance from the perspective of customers in the supply chain. Further, there are limitations to the depth of data that can be collected via surveys. It may be useful for future studies to identify other factors that enhance the implementation of environmental supply chain practices through the collection of more in-depth qualitative data. While the single industry focus offers some advantages, it may limit the generalisability of the findings to other industries. Again, this is something that future studies might address through consideration of these relationships in other manufacturing or service contexts.

## **6 Conclusions**

This study has investigated the role of downstream environmental logistics in generating performance improvements through the lens of the NRBV. The outcomes considered were environmental and cost performance, with attention given to the potential for stakeholder engagement to enhance these outcomes. Our results provide support for a number of the arguments of the NRBV (Hart 1995; Hart and Dowell 2011). Considered together, our results suggest that companies in the food industry may be able to improve both their environmental and their cost performance by implementing environmental logistics practices downstream in the supply chain. Engagement with their key customer stakeholders may facilitate this implementation, generating greater improvements in performance outcomes.

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