Performance outcomes of environmental collaboration: evidence from Finnish logistics service providers

Abstract

Purpose The focus of environmental activities has shifted from the level of the company to that of the supply chain. Firms that are intent on addressing growing concerns about the environmental impact of their activities could benefit from collaborating internally and externally. This paper develops and empirically tests a theoretical model of the effects of internal and external environmental collaboration with customers on firm performance of logistics service providers.

Design/methodology/approach Hierarchical multiple regression and generalised linear modelling are utilised to analyse 311 logistics service providers offering road transport services in Finland. The dataset was collected from a Finnish nationwide logistics survey in 2012 and financial reports-based data.

Findings External environmental collaboration with customers seems to be the most effective type of environmental collaboration to improve operational and financial performance, while internal environmental collaboration does not yield similar benefits.

Research limitations/implications Research limitations include the concentrated geographic origin of the respondents and the exclusion of potential indirect effects of environmental collaboration on operational and financial performance through environmental performance.

Practical implications The results indicate that managers planning to implement environmental initiatives should extend their focus from internal operations to external partners in the supply chain.

Originality/value This research is one of the first attempts to focus on performance outcomes with regard to the environmental activities of logistics service providers. The research provides quantified insights using both self-reported and financial reports-based data.

Keywords Environmental collaboration, Operational performance, Financial performance, Logistics service provider, Finland

Paper type Research paper

Introduction

Rapid growth in freight and passenger transport has raised concerns about the environmental impact of the sector. For example, regulatory bodies such as the European Commission have called for significant reductions in greenhouse gas emissions (European Commission White Paper on

Transport, 2011). However, making transport greener involves more than abating carbon emissions, such as cutting other atmospheric emissions, and reducing noise, waste and land use (Publications Office of the European Union, 2012). External pressure from stakeholders drives firms to engage into environmental activities (Kim & Lee, 2012). Companies need to react to these challenges, hence the heightened interest in the integration of environmental thinking into supply chain management in academia and business (Evangelista et al., 2010; Lin & Ho, 2011). Green supply chain management (GSCM) has emerged as a way to combine environmental management and supply chain management (Srivastava, 2007). The focus in the paper is on a specific type of GSCM, environmental collaboration (Vachon & Klassen, 2008). As environmental issues do not only affect an independent company, firms may collaborate internally or externally with their partners in the supply chain to address environmental concerns, (Stank et al., 2001a; Linton et al., 2007).

Logistics service providers (LSPs) are in a critical position to support efforts to improve environmental sustainability of supply chain operations (Perotti et al., 2012) through collaboration and integration of logistics management activities (Lam & Dai, 2015). However, most of the research thus far has concentrated on the efforts of manufacturers and retailers (Lieb & Lieb, 2010), and LSPs have received limited attention (Lin & Ho, 2008; Evangelista et al., 2010; Lieb & Lieb, 2010). Further, the services industry has traditionally been assumed to have a much smaller environmental impact than manufacturing (Ramus & Montiel, 2005; Lin & Ho, 2008), yet the logistics industry may be more harmful to the environment than other service industries and exhibit dissimilar attitudes toward environmental issues (Wu & Dunn, 1995; Lin & Ho, 2008).

Although there is evidence of a positive connection between environmental management and performance in a manufacturing setting (see e.g., Rao & Holt, 2005; Vachon & Klassen, 2008; De Giovanni & Esposito-Vinzi, 2012; Zhu et al., 2013), there is a need for large-scale empirical testing of the results of the few exploratory studies within logistics sector (Perotti et al.; 2012; Yang et al.; 2013) and for clarifying whether the connections reported in manufacturing are applicable to LSPs. Although there are some studies on issues such as the adoption of green practices among LSPs (Lin & Ho, 2008; Evangelista et al., 2010) and the interface between LSPs and shippers (Martinsen & Björklund, 2012), the performance outcomes of such activities remain largely obscure.

Drawing on the relational view (Dyer & Singh, 1998) and the natural-resource-based view (Hart, 1995), this paper attempts to narrow this research gap by identifying empirically the effects of environmental collaboration in the supply chain on the financial and operational performance of 311 logistics service providers offering road transport services in Finland. The former refers here to how well the firm performs in terms of measures compiled from its financial statement, whereas the latter refers to operational efficiency. While the previous studies in other industries have analysed financial performance, empirical examinations of the relationship between GSCM practices and operational performance are still limited and contradictory (Yu et al., 2014). Hence, it is necessary to extend existing literature by exploring the effect of environmental collaboration on operational performance.

Although much previous literature within GSCM exists, the majority has utilized self-reported measures from a single source (Wang & Sarkis 2013; Seuring & Muller 2008). While there are some studies that have combined data from multiple sources (e.g. Markley & Davis 2007; Wang and Sarkis 2013), the samples tend to be biased towards environmentally proactive companies. Hence, research focusing on actual and preferably more objective data on financial performance, such as share price, market share and return on assets, is needed (Zhu & Sarkis, 2007). One of the novelties in this research is that it combines self-reported survey data with data from financial reports. Given the growing demand for greener logistics services (Wolf & Seuring, 2010), a better understanding of the relationships between environmental practices and firm performance is needed. This article contributes to the limited body of knowledge on the performance outcomes of environmental management in the logistics sector through the development of a model to evaluate the connection between environmental collaboration and operational and financial performance. The findings offer practical implications for managers of logistics companies in terms of recognising the most effective ways of improving operational and financial performance through environmental collaboration.

The article comprises five sections. This introduction is followed by a review of previous literature on environmental collaboration and firm performance, on the basis of which five research hypotheses are postulated. Section three describes the research methodology, including the sampling techniques, measures and the data analysis. Section four presents the results of the empirical analysis. Conclusions are drawn and the implications of the findings are discussed in the final section of the paper.

Theoretical background and research hypotheses

Environmental collaboration

Recently, green supply chain management (GSCM) has emerged as the management of upstream and downstream supply chains, with capability to minimise the overall environmental impacts (Yu et al., 2014). GSCM combines the elements of corporate environmental management and supply chain management (Yang et al., 2012). Srivastava (2007) defines GSCM as integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life. Previous literature divides the determinants of GSCM adoption into external factors mostly linked to stakeholder pressure, and internal factors stemming from business-led strategic processes (Testa & Iraldo, 2010).

Several theoretical lenses have been applied in research focusing on GSCM. This article builds upon two extensions of the resource-based view (RBV); the natural-resource-based view and the relational view. The RBV maintains that the resources a firm possesses may provide a source of competitive advantage (Barney, 1991). According to the natural-resource-based view (NRBV), strategy and competitive advantage can be created from firm-specific capabilities facilitating environmentally sustainable economic activities if a resource is valuable, rare, inimitable and non-substitutable (Hart, 1995). However, a number of studies have challenged the requirement for firm-specificity and combine the relational view with the NRBV, arguing that environmental management in the supply chain can create competitive advantage (e.g. Vachon & Klassen, 2008; Shi et al., 2012). According to the relational view, a firm’s critical resources can extend beyond its boundaries and hence be developed by combining the resources of various partners in the supply chain (Dyer & Singh, 1998; Vachon & Klassen, 2008). Several studies (e.g. Vonderembse & Tracey, 1999; Stank et al., 2001a; Das et al., 2006; Flynn et al., 2010) provide empirical evidence that close relationships with these partners are positively related to performance in terms of a high level of customer service, shorter time-to-market, decreased costs and increased sales.

Building on these ideas, Vachon and Klassen (2008) study environmental collaboration which can be seen as specific type of GSCM. It is defined as "the direct involvement of the focal organisation with its suppliers and customers in planning jointly for environmental management and environmental solutions" (Vachon & Klassen, 2008, p. 301). Environmental collaboration differs from the environmental monitoring that is conducted by the buying organisation in an arm's-length relationship to monitor and control its suppliers: it requires more resources to be dedicated to developing cooperative activities in order to focus more on the process of making operations and products more environmentally friendly rather than on the immediate outcome of environmental efforts (Vachon & Klassen, 2006). Although environmental collaboration is somewhat related to supply chain collaboration that has been on the research agenda for years (see e.g. Sanders and Premus, 2005; Wu et al., 2006; Fabbe-Costes et al., 2009; Flynn et al., 2010; Cao and Zhang, 2011), managing environmentally and economically sustainable collaboration is in many ways more complex and requires more efforts than conventional supply chain collaboration (Kuik et al., 2011).Collaboration could also be seen as an embedded element of GSCM practices influencing various phases of supply chain, such as product design, purchasing, manufacturing and delivery (Srivastava, 2007). However, for the purpose of this paper environmental collaboration is considered a separate activity.

Traditionally, supply chain collaboration has been divided into two broad categories: internal and external collaboration (e.g. Stank et al., 2001a; Barratt, 2004). The former takes place within the firm and the latter with partners in the supply chain, such as suppliers and customers. Similarly, GSCM is often classified into internal practices within the firm and external practices with supply chain partners (e.g. Rao & Holt, 2005; Zhu et al., 2007; De Giovanni & Esposito Vinzi, 2012; Yang et al., 2013). Following the logic of the previous studies, environmental collaboration could also be categorised as internal and external.

Reflecting Yang et al. (2013) and Martinsen and Björklund (2010), internal environmental collaboration is defined here as involving 1) green policy (e.g., a clear statement of environmental policy, the commitment and support of staff for environmental initiatives and cross-functional cooperation in environmental protection); 2) green transport (e.g., fuels, vehicle technologies, modal choice, behavioural aspects, logistics systems design, transport management, choice of partners, environmental management systems, and emissions and energy data); and 3) green marketing (i.e. providing customers with information about green services, higher spending on green advertising, promoting resource and energy conservation in marketing, attracting customers with green initiatives and eco-services, and publishing information on environmental issues on the company website). All these elements work in combination across different functions to improve environmental processes.

External environmental collaboration is defined as working jointly with suppliers and customers to set and achieve goals that lessen the environmental impact with regard to the coordinated activities (Vachon and Klassen, 2006; Green et al., 2012). Typical carriers mainly perform the physical transport of the products and are often are owners or leasers of the trucks and the equipment needed for their operation (Stefansson, 2006). These transport companies often serve as sub-contractors in larger transport networks (Sternberg et al., 2013). The main customers of LSPs include shippers and forwarders. It is possible for larger LSPs to outsource some of their activities, such as specialised transportation, and hence to collaborate. However, in general the opportunity to collaborate with suppliers such as vehicle manufacturers and fuel companies is marginal. Hence, this article focuses on environmental collaboration internally and downstream with customers.

Cross-influence of internal and external environmental collaboration

Previous research has shown that a higher level of internal environmental collaboration facilitates the adoption of external environmental collaboration (e.g., De Giovanni & Esposito Vinzi, 2012; Zhu et al., 2013, Yang et al., 2013). However, some organisations may symbolically adopt internal environmental practices to enhance their reputation without reducing their environmental impact, whereas others may unintentionally fail to address the environmental effects of their supply chain partners (Shi et al., 2012). A high level of internal communication and coordination capabilities increases the likelihood that the company will achieve a high level of external collaboration, evaluate new knowledge acquired from external partners in the supply chain and understand their business, thereby facilitating external integration (Yang et al., 2013). Implementing collaborative inter-firm programmes is less problematic when the partners in the supply chain are internally green (De Giovanni & Esposito Vinzi, 2012).

Arimura et al. (2011) used Japanese facility-level data and found that certified ISO14001 certified firms were 40 % more likely to assess their suppliers' environmental performance and 50 % more likely to require that their suppliers follow specific environmental practices. In addition, Darnall et al. (2008) conclude that adopters of environmental management systems are more likely to impose indirect control mechanisms on suppliers, and consequently improve the environmental sustainability of their firm and their network of suppliers and customers. Thus, an environmental management system, such as ISO 14001 or EMAS, might affect the level of internal and external environmental collaboration. The effect of such certification, however, is out of the scope of this article. Based on the results of the previous studies, it is proposed that:

Hypothesis 1. Internal environmental collaboration is positively associated with external environmental collaboration with customers in the context of road transport services.

Internal environmental collaboration and firm performance

Performance is frequently used as the desired outcome following the implementation of organizational actions in order to reach objectives and targets (Lebas, 1995). Firm performance is often classified in relation to three main dimensions: financial or economic performance, operational performance and environmental performance (Zhu et al., 2007; Perotti et al., 2012). Given that several authors have previously revealed a positive direct effect of environmental initiatives on environmental performance (e.g. Zhu et al., 2007; Zhu et al., 2013; Yang et al. 2013) and that few companies would initiate environmental projects without anticipating such results, this article concentrates on the other two dimensions, namely financial and operational performance.

In the case of internal collaboration, different departments and functional areas should operate as part of an integrated process. With the breaking down of functional barriers and enhanced cooperation to meet customer requirements, inter-departmental integration is expected to relate to performance (Flynn et al., 2010). A number of previous studies report a positive relationship between inter-departmental integration and various aspects of performance such as improvements in customer service, lower inventory levels and higher forecasting accuracy (Kahn & Mentzer, 1996); responsiveness and flexibility (Stank et al. 1999, Flynn et al., 2010); and enhanced financial performance and market competitiveness (Biehl et al., 2006; Chen et al., 2007; Flynn et al., 2010).

Similar findings among manufacturers have been reported in terms of internal environmental collaboration (e.g. Klassen & McLaughlin, 1996; De Giovanni & Esposito Vinzi 2012) and Italian third-party logistics service providers (Perotti et al., 2012). It can be argued that a firm can achieve superior performance if it has the capability to exploit as well as sustain natural resources in its operating environment (Wong et al., 2012). Internal GSCM practices, such as top management support, and environmental management systems and certifications, have been acknowledged as comprehensive mechanisms to achieve superior performance (Zhu et al., 2013; 2004; Yu et al., 2014). Intra-organisational environmental practices develop over time in organisations and create tacit knowledge and efficient management routines that are causally ambiguous to the competitors and, consequently, improve the organisational performance (Shi et al., 2012), while the non-adoption of internal environmental management practices could be a source of disadvantage (Perotti et al., 21012). Environmental collaboration can also indirectly improve financial performance through the enhancement of operational performance, such as decreasing inventory levels and enhancing product quality (Zhu et al., 2005).

Although this study examines financial performance and uses traditional measures compiled from financial statement (EBIT percentage, ROI and ROA), while many of the previous studies focus on economic performance and use perception-based indicators, such as opinion on the development of market share and cost savings, parallel results could be expected. Hence, a series of hypotheses are proposed:

Hypothesis 2a. Internal environmental collaboration is positively associated with Earnings before Interest and Taxes percentage in the context of road transport services.

Hypothesis 2b. Internal environmental collaboration is positively associated with Return on Investment in the context of road transport services.

Hypothesis 2c. Internal environmental collaboration is positively associated with Return on Assets in the context of road transport services.

Although many studies seem to include economic performance among the outcomes of environmental management, there is limited research on the connection with operational performance (Zhu et al., 2013; Yu et al., 2014). Environmental management practices are embedded in business operations and can consequently lead to performance benefits, such as cost savings and increased efficiency (Yu et al., 2014). Beamon (1999) claims that firms in the early stage of adopting environmental management separate environmental from operational performance, but as they evolve they start to integrate environmental and operational objectives. Eco-efficiency increases resource productivity and helps to cut down costs associated with unnecessary waste, defects and stored materials (Porter & van der Linde, 1995). Pollution prevention means waste reduction, which in turn improves operational performance through the better utilisation of inputs, reduced cycle times and lower costs (Golicic & Smith, 2013).

However, the extent to which the results of existing studies apply to LSPs remains unclear. According to Perotti et al. (2012), Italian LSPs reported a minor effect on operational performance. Environmentally responsible logistics practices tend to favour fewer shipments, less handling, shorter moves, more direct routes and better space utilisation (Wu and Dunn, 1995), all of which should result in improved operational performance. This study examines five operational performance measures by Johnston (2010): empty mile percentage, average transport performance, average length of haul and average load factor in domestic and international shipments. Johnston (2010) argues that these are measures used by motor carriers to manage day-to-day operations and improvements in these performance measures can increase asset utilisation and ultimately financial performance. It is anticipated that LSPs would increase the total number kilometres per trip to spread the fixed costs over the widest possible base (Baker, 1989). While average length of haul is a useful measure to separate short-distance from long-distance shipments (Cotrell 2008), monitoring of load factors is based on the assumption that high load factors will produce high revenues per tractor (Baker, 1989). Finally, the empty-mile percentage can be considered an important measure to the logistics industry given that empty running can be considered waste of resources (Cotrell, 2008).

Hence, it is postulated that:

Hypothesis 3a. Internal environmental collaboration is negatively associated with empty mile percentage in the context of road transport services.

Hypothesis 3b. Internal environmental collaboration is negatively associated with average transport performance in the context of road transport services.

Hypothesis 3c. Internal environmental collaboration is negatively associated with average length of haul in the context of road transport services.

Hypothesis 3d. Internal environmental collaboration is positively associated with average load factor in domestic shipments in the context of road transport services.

Hypothesis 3e. Internal environmental collaboration is positively associated with average load factor in international shipments in the context of road transport services.

External environmental collaboration and firm performance

Firms form highly collaborative relationships with some members of the supply chain, and arm's-length relationships with others (Gimenez & Ventura, 2005). Nevertheless, they need to collaborate with a small number of strategically important suppliers and customers (Barratt, 2004). External environmental collaboration entails arriving at a mutual understanding of environmental risks and responsibilities, and sharing resources, skills and knowledge, and it requires a shared willingness to learn about each other's operations in order to formulate and achieve common goals for environmental improvement (Vachon & Klassen, 2008; Yang et al., 2013). Environmental collaboration with partners in the supply chain requires the firm to be capable of effectively integrating internal and external knowledge, skills and technology (Yang et al., 2013). It can facilitate inter-organisational learning (Vachon & Klassen, 2008) and reinforce efficiency and synergy among business partners (Yang et al., 2013), translating into better performance in the form of cost reduction and thus higher profits (Rao & Holt, 2005). Organisational environmental practices generate socially complex resources that prevent competition by being difficult to imitate (Shi et al., 2012). Environmental collaboration with customers reduces business waste and environmental costs, increases customer satisfaction, and at the same time maximizes the return volumes (Azevedo et al., 2011). Moreover, an improved corporate image could help the firm to replace competitors that fail to address environmental issues (Klassen & McLaughlin, 1996).

Empirical studies in the manufacturing sector (e.g., Rao & Holt, 2005; De Giovanni & Esposito Vinzi, 2012; Zhu et al., 2013) and in container shipping (Yang et al., 2013) have identified a positive connection between environmental practices in the supply chain and economic performance. Environmental collaboration with customers facilitates identifying and fulfilling customer needs. Improved customer satisfaction and corporate image can bring financial benefits (Zhu et al., 2013). By adding more value to product or service offerings firms can secure more market share and revenue compared to their competitors (Hong et al., 2009). Hence, it is postulated that:

Hypothesis 4a. External environmental collaboration with customers is positively associated with Earnings before Interest and Taxes percentage in the context of road transport services.

Hypothesis 4b. External environmental collaboration with customers is positively associated with Return on Investment in the context of road transport services.

Hypothesis 4c. External environmental collaboration with customers is positively associated with Return on Assets in the context of road transport services.

Findings from several studies (e.g. Germain and Iyer, 2006; Flynn et al., 2010) on traditional forms of supply chain collaboration support the relationship between downstream collaboration and improved operational performance. Relationships are key success factors among LSPs, enabling both users and service providers to collaborate closely to reduce costs and improve delivery quality, reliability, speed and flexibility, and thus further improve performance (Wong & Karia, 2010). Environmental collaboration among partners in the supply chain is expected to reduce the use of natural resources, improve efficiency and productivity, and reduce operating costs (Klassen & McLaughlin, 1996; Rao & Holt, 2005). Close collaboration with customers enable planning shorter vehicle routes and backhauls, for example (Azevedo et al., 2011). Hence, it is proposed that:

Hypothesis 5a. External environmental collaboration with customers is negatively associated with empty mile percentage in the context of road transport services.

Hypothesis 5b. External environmental collaboration with customers is positively associated with average transport performance in the context of road transport services.

Hypothesis 5c. External environmental collaboration with customers is negatively associated with average length of haul in the context of road transport services.

Hypothesis 5d. External environmental collaboration with customers is positively associated with average load factor in domestic shipments in the context of road transport services.

Hypothesis 5e. External environmental collaboration with customers is positively associated with average load factor in international shipments in the context of road transport services.

Figure 1 below illustrates the above hypotheses derived from the literature.

<insert Figure 1 here>

Figure 1. Key concepts and research hypotheses

Methodology

Dataset

A sample of data from a national Finnish logistics survey was combined with detailed financial reports-based data extracted from the Finnish Voitto database of financial reports, the aim being to estimate the impact of environmental collaboration on the operational and financial performance of logistics service providers. The authors collected the survey data during January-February 2012 as part of the Finland State of Logistics 2012 survey, by means of a web-based questionnaire. The sample frame comprised all non-student members of the Finnish Association of Purchasing and Logistics (LOGY), members of the Finnish Transport and Logistics association (SKAL), and members of the Federation of Finnish Enterprises that were active in the industries covered in the survey. Over 97 % of Finnish firm operating in transportation and storage sector, as covered by NACE rev. 2 section H, are micro-sized (Statistics Finland, 2015). In the current sample, 66 % of firms were micro-sized. Thus, measured as turnover, the sample represents a larger share of the industry.

In total, 684 responses from LSPs were received. Given that the items measuring operational performance were not applicable to air, sea or railway traffic, 78 responses from these industries were omitted. Next, financial data was extracted from the Voitto database. Firms whose financial reporting data was unavailable were omitted. Thus, the sample for this research consists of 311 LSPs offering road transport services.

The sample comprises responses from the following industries: Freight transport by road, 230 responses; supporting and auxiliary transport activities, 31 responses; storage and warehousing, 23 responses; courier activities other than national post activities, 14 responses; other scheduled passenger land transport, 12 responses; and national post activities, 1 response. The majority (80 %) of the respondents identified themselves as in the top management of the firm, while ten per cent were among middle management. The remaining 10 per cent of respondents represented other tasks in the company.

<Insert Figure 2 here>

Figure 2. Data sources used in the study

The response rate raises the question of potential non-response bias, and therefore it was decided to compare the early and late respondents (Armstrong & Overton, 1977). An independent samples t-test carried out on the two groups' perceptions of environmental collaboration and operational performance revealed no significant differences (at $p < 0.05$) in the means, which indicates no evidence of non-response bias.

In order to address potential common method bias caused by collecting most of the research variables through the same survey, the authors applied a set of procedural remedies suggested by Podsakoff et al. (2003). Furthermore, the survey responses were combined with the financial data from the Voitto database based on the business identity codes in order to counteract the potential impact of common method bias arising from using a single source. It was also necessary to avert the possible consistency motive, thus the dependent and independent variables were separated and placed in different phases of the survey, and different scales were used.

The development of the measures

Despite the growing interest among LSPs in environmental issues, previous studies have focused on manufacturing companies. Earlier research on manufacturing companies was taken as a starting point for developing items measuring environmental collaboration among LSPs. External environmental collaboration with customers was measured on the scale developed by Vachon and Klassen (2008), who assessed environmental collaboration in the supply chain on two sets of questions, one on collaboration with key suppliers and the other on collaboration with key customers. It is likely that smaller LSPs, especially in road transport, do not have the possibility to form the kind of strategic alliances that large container shipping firms enter into. Hence, given the small firm size of the majority of respondents and thus their limited abilities to collaborate with their suppliers, the items measuring environmental collaboration with suppliers were considered unsuitable for this research.

Given that Vachon and Klassen's (2008) original scales did not measure internal environmental collaboration and in order to include all dimensions of collaboration as suggested by Flynn et al. (2010), a new set of items measuring environmental collaboration within the firm was constructed based on Vachon and Klassen's (2008) scales. Each type of environmental collaboration was assessed on five questionnaire items using a five-point Likert scale in which 1 corresponds to "strongly disagree" and 5 to "strongly agree."

Operational performance refers here to the operational efficiency of LSPs, in other words to internal-facing measures of how efficiently an LSP uses its resources to perform its day-to-day service activities (Lai et al., 2002). The measures developed by Johnston (2010) were used in this research. In order to measure asset utilization, the empty-mile percentage and the average load factor (%) in both domestic and international shipments were included in the analysis. Average transport performance per vehicle (km), and average length of haul (km) were also included to test the efficiency of the vehicle routing.

Financial performance was measured in terms of Return on Assets (ROA) (Watson et al., 2004), Return on Investment and the Earnings Before Interest and Taxes (EBIT) percentage (Wagner, 2005). The first two are asset-based measures, which might behave differently from profitability measures. Thus, the EBIT percentage was also included in the analysis.

In addition, three control variables were used as follows: firm size was measured as turnover and divided between micro-sized (n=204) and small-to-large-sized firms (n=107) on the basis of the turnover criterion in the European Commission's definition; the single largest customer's turnover share (%) to assess dependence on the largest customer, which in turn might affect the willingness to collaborate; and the part of the value chain the company mainly serves (manufacturing (n=197) or trading (n=82)). Table I summarises the measurement items.

Table I Measurement items

<Insert Table 1 here>

The distributions of the dependent and independent variables were assessed for the purpose of regression analysis. A logarithmic transformation was applied to TRANSPERF and LENGTH, and a square root transformation to EMPTY to reduce the positive skewness. A small number (10^{-3}) was deducted from DOMESTIC and INTERNATIONAL in order to compare the potential distribution candidates (Gamma, Beta and normal distribution). In line with Schwarz's Information Criteria (Schwarz, 1978), Beta distribution was considered the most suitable for the analysis of DOMESTIC and INTERNATIONAL, and normal distribution was applied to the other variables (Table II). Clearly erroneous responses were excluded, such as values of transport performance that were clearly impossible to achieve under existing speed limits and regulations on driving and rest periods, and zero values in INTERNATIONAL for firms indicating that they only had domestic shipments.

Two outlying cases were excluded from the ROI analysis: the first had a ROI ratio of -410 which is exceptionally low while another firm had a ROI ratio of 181 which is exceptionally high. These values do not depict a normal financial situation and were hence excluded.

Table II Descriptive statistics of research variables

<Insert Table 2 here>

Data analysis methods

First, confirmatory factor analysis (CFA) was used to test the validity and reliability of the items measuring environmental collaboration. Convergence and discriminant validity were also assessed within the CFA. The Cronbach's alphas were then calculated to assess the scales for internal reliability. Second, hierarchical multiple regression analysis was used to test the hypotheses for normally distributed variables while generalised linear modelling (GLM) was used to test the hypotheses for Beta distributed variables. The latter is a generalisation of ordinary regression and also allows distributions other than normal. The hierarchical multiple regression models were executed in three steps. In Step 1, the performance measures were regressed only against the control variables. In Step 2, internal environmental collaboration was introduced, and in Step 3 external environmental collaboration with customers was added to the model. IBM SPSS Statistics 22, SAS 9.3 and LISREL 9.1 statistical packages were used for the analyses.

The results of the measurement model

The constructs of environmental collaboration were derived from previous research (Vachon and Klassen, 2008). Given that the relationship between environmental and general supply chain collaboration has not been widely covered in the literature, it was necessary to ensure that the measures of environmental collaboration were not perceived by the respondents as elements of general collaboration in the supply chain.

Previously, two sets of questions measuring internal and external collaboration in the supply chain were used in the Finland State of Logistics 2010 survey (Solakivi et al. 2010), but were not included in the Finland State of Logistics 2012 survey used in this article. In order to check the validity of the measures a total of 127 LSPs who had responded to Finland State of Logistics 2010 and 2012 were identified, and the correlations between the responses related to supply chain collaboration and environmental collaboration were compared. The analysis revealed small correlations: 0.073 for internal collaboration and 0.136 for external collaboration, indicating that the measures used in this article measure environmental collaboration, and do not merely act as proxies for more general supply chain collaboration.

Further, a confirmatory factor analysis was conducted on the scales measuring environmental collaboration using maximum likelihood estimation. Modification indices and standardised residuals were used to improve the fit of the model. A step-by-step examination of the modification indices revealed that items INT2, CUST1 and CUST4 did not adequately measure the latent variables, and they were removed as a consequence. A final CFA was conducted on the remaining seven items and the results are shown in Table III.

Table III The results of the final CFA

<insert Table 3 here>

The average variance extracted (AVE) values for all the constructs turned out to be higher than 0.50. The fit indices show a good fit (Hu & Bentler, 1999) (X^2= 27.810, X^2/df = 2.139, GFI = 0.964, AGFI = 0.923, CFI = 0.991, NFI = 0.983, IFI = 0.991, RMSEA = 0.074, p-value = 0.010). The results indicate uni-dimensionality and reliability of the model. All the factor loadings are above the generally accepted cut-off criterion of 0.7 (Garver & Mentzer, 1999), indicating that convergent validity is achieved. Pairwise X^2 difference tests were conducted to assess the discriminant validity (Anderson & Gerbing, 1988), first by fixing the correlation between the latent variables at 1.0, and then by freeing the correlation. The X^2 difference between the fixed and the constrained model was 351.168 with one degree of freedom, which is statistically significant ($p < 0.001$) and suggests discriminant validity. For the further analyses, the average of the items for each scale were computed to form two new variables. The Cronbach's alphas were 0.907 for internal environmental collaboration and 0.932 for external environmental collaboration. The unidimensionality of the scales was cross-checked by conducting a principal component analysis on each scale individually. For both scales, the items loaded on a single factor, with variance extracted being 73 % for internal environmental collaboration and 85 % for external environmental collaboration with customers. The arithmetic means were used as single-indicator constructs to measure internal and external environmental collaboration in subsequent stages.

Results

The results of the hypothesis testing

Firstly, Hypothesis 1 was tested with regression analysis, resulting in a coefficient of 0.717 ($p<0.001$) for internal environmental collaboration and 0.005 ($p<0.05$) for single largest customer's share of turnover (Adjusted R square = 0.387). This provides strong support for Hypothesis 1. Regression analysis and generalised linear modelling were used to analyse the relationships among internal environmental collaboration, external environmental collaboration with customers, operational performance, and financial performance. Table IV provides the correlation matrix of the research variables while Table V shows the results of hierarchical multiple regression.

Table IV Pearson correlations of the research variables

<insert Table 4 here>

Table V Model-based results

<insert Table 5 here>

Based on R^2 values presented in Table V, the best fit for empty mile percentage, average length of haul, EBIT percentage, ROI and ROA was achieved when the model included both independent variables and control variables (Step 3). For average transport performance per vehicle the model with only control variables obtained the highest R^2 value. Generalised linear modelling was used to analyse the Beta distributed indicators of average load factor in domestic and international shipments. GLM does not produce R^2 values and hence Bayesian Information Criterion (BIC) was used to assess the goodness of the models. Based on BIC, the model with only control variables (Step 1) can be considered most suitable in assessing both load factors. The post hoc power analysis indicates that the power for each best fitting model exceeds 0.90 with an alpha level of 0.05, which is sufficiently high (Cohen, 1992).

Based on the beta coefficients presented in Table V, internal environmental collaboration seems to have a statistically significant negative effect on ROI. External environmental collaboration between LSPs and their customers has a statistically significant positive impact on EBIT percentage, ROI and ROA. With regard to operational performance, the analysis revealed that there is a statistically significant positive connection between average load factor in domestic shipments and external environmental collaboration with customers (Step 3) although the model as a whole was found less suitable than the model containing only control variables.

Table VI gives the results of the hypothesis testing. It can be concluded that hypotheses H1, H4a, H4b, H4c and H5d are supported whereas hypotheses H2a, H2b, H2c, H3a, H3b, H3c, H3d, H3e, H5a, H5b, H5c and H5e are not supported.

Table VI The results of the hypotheses testing

<insert Table 6 here>

Although environmental collaboration seems to have an impact on few measures of operational and financial performance, company size, the part of the value mainly served and the single largest customer's share of turnover appear to have several statistically significant connections. Firms that mainly serve manufacturing generally have higher load factor in domestic shipments and higher average transport performance per vehicle. Furthermore, larger firms have higher transport performance and longer average length of haul. The share of the largest customer increases all but one measure of operational performance.

Conclusions and discussion

Theoretical and managerial implications

This study is one of the first to evaluate the linkages between environmental activities and performance among LSPs. This article focuses on LSPs offering road transport services. In addition, the current article contributes to the scarce research on the implications of GSCM on operational performance (Yu et al., 2014). It addresses the need to focus on the relationship between GSCM practices and several performance dimensions in the context of LSPs, in particular by using the survey method that enables empirical generalisations to validate the results of exploratory case studies (Evangelista, 2014; Perotti et al., 2012). This article is also one of the few empirical studies on GSCM combining survey data with data from financial reports.

The results of the hypothesis testing in the context of road transport services by means of hierarchical multiple regression and generalised linear modelling are somewhat consistent with findings reported in previous studies in a manufacturing setting (e.g., Vachon & Klassen, 2008; Zhu et al., 2013), and also in container shipping (Yang et al., 2013). The empirical findings of this study (H1) support the conclusion reached by Yang et al. (2013) who suggest that pursuing internal green practices is a successful way of enhancing external environmental collaboration. The analysis of the relationship between environmental collaboration and financial performance measures revealed contradictory results. Internal environmental collaboration was found to reduce ROI supporting the views put forward by Zhu et al.'s (2013) conclusion that internal green practices and economic performance are negatively connected. They suggested that the respondents were still at the early stage of GSCM implementation with significant start-up investments while direct cost savings were yet to be achieved. This might also explain why Finnish LSPs face a negative impact of internal environmental collaboration on ROI, given that the integration of green thinking into the operations of the LSPs might still be at an early stage (Isaksson & Huge-Brodin, 2013). Hence, hypotheses H2a, H2b and H2c were rejected. On the other hand, the results of this study revealed positive connections between external environmental collaboration with customers and EBIT percentage and the two asset-based measures of financial performance, ROI and ROA (H4a, H4b and H4c). ROI had the strongest relationship with customer collaboration. The current result implies that financial performance of a company can be improved while also reducing the environmental burden.

Operational performance measures (H3a-e, H5a-e), in turn, were considerably less affected by environmental collaboration. Only average load factor in domestic shipments were found to be improved by external environmental collaboration with customers (H5d). The results imply that the profitability of a company might be improved through better vehicle utilization. McKinnon and

Edwards (2012) maintain that raising vehicle load factors is one of the most attractive sustainable distribution measures to companies, and mention several factors aimed at improving vehicle loading such as increasing backloading, using more space-efficient packaging and improving reliability in the logistics schedules. The lack of other statistically significant relationships between environmental collaboration and operational performance measures is supported by work of Perotti et al. (2012) who found in their case study that green supply chain practices had only a low impact on the operational performance of Italian LSPs.

The control variables of firm size, part of value chain mainly served and the share of the single largest customer had several statistically significant effects on operational performance measures. Larger firms were found to have higher transport performance per vehicle and longer average hauls. Micro-sized firms might focus more on local customers and routes. Furthermore, firms that mainly serve manufacturing generally had higher load factor in domestic shipments and higher average transport performance per vehicle than firms that mainly serve trading. While the part of the value chain mainly served did not affect the average length in the current study, the type of the customer undoubtedly has an impact. For example, customers requiring small just-in-time (JIT) deliveries can lead to increased transportation (Mollenkopf et al., 2010). Many respondents in Liimatainen et al.'s (2012) survey study of Finnish road freight hauliers mentioned better planning to increase the size of shipments as a way in which their customers could promote energy efficiency, in addition to being willing to pay a higher price for eco-friendly transport services. Finally, the single largest customer's share of turnover was found to have significant effects on most of the operational measures. It seems that having a single or a few large customers seems to enable the LSP to better utilise its vehicle capacity: it may be easier to bring about freight consolidation among just a few customers, for example.

In conclusion, it is suggested in this study that external environmental collaboration with customers is the right choice in terms of financial performance of LSPs. This result differs from the findings reported by De Giovanni and Esposito Vinzi (2012) who argue that the most effective way of enhancing performance is via internal environmental management. It should be noted, however, that the results of the present study only apply to internal environmental collaboration and external environmental collaboration with customers while future research is needed to address the effects of environmental collaboration with suppliers. Although the results revealed that internal environmental collaboration had a negative connection with ROI, no firm collaborates externally in environmental issues unless it has some environmental goals and has considered some means of achieving them. Hence, the results should not be interpreted as a recommendation to entirely abandon internal environmental collaboration but rather as a suggestion not to neglect the broader supply chain perspective. Taken as a whole, the results imply that firms seeking performance gains from environmental practices should extend their focus from internal operations to external partners in the supply chain.

Based on the findings of this study, reassessing load factors is among the most effective ways of addressing environmental issues while not compromising economic performance. McKinnon and Edwards (2012) point out that the ability of an individual company to improve its vehicle utilisation is limited if the supply chain partners are unwilling to collaborate. Thus, managers will need to consider what type of a relationship to develop with each supply chain partner to be able to accommodate both environmental and financial needs. On a more operational level, useful measures for managers to consider include for example vehicle routing, vehicle utilisation and backhaulage.

Given that some firms might be reluctant to go beyond regulatory compliance, it is necessary to highlight that good environmental reputation can improve a firm's attractiveness to consumers, organisational customers, investors and new employees.

The Finnish transport sector is dominated by micro- and small-sized firms who might not have the necessary financial resources and knowhow to address environmental sustainability (Hillary, 2004). Environmentally advanced customers can support LSPs by providing training and collaborative research and by sharing environmental management information (Lee, 2008). The problem could also be addressed for example by providing SMEs less formal environmental management systems and environmental counselling. Thus, it is essential for municipalities to train their business advisors in environmental issues. In addition, other actors, such as chambers of commerce, interest groups etc. can organise training on environmental issues and spread knowhow. Voluntary environmental schemes need to be complemented with policy measures that promote environmentally sustainable business.

Limitations and future research

There are some limitations to the study that should be noted. First, the sample of respondents was restricted to LSPs offering road transport services and operating in Finland. Future research might benefit from collecting data from other industries or other countries. Further, most respondents are micro-sized. Although this sample gives a truthful picture of the Finnish logistics market, a targeted sample of larger companies might give new insights, as micro-sized firms tend to be laggards in terms of environmental proactivity (e.g. Lepoutre & Heene, 2006). Second, the findings on the effects of external environmental collaboration only apply to customer-side of the supply chain. A sample of larger firms might enable assessing environmental collaboration with suppliers and thus examining together internal, upstream and downstream sides of environmental collaboration. Furthermore, performance outcomes of environmental collaboration with other stakeholders, such as non-governmental organisations, research institutions and government actors, could be an interesting future research area. Third, environmental performance was not measured. Future research could investigate whether environmental collaboration has an indirect effect on operational and financial performance through environmental performance. Fourth, service performance was not included in operational performance. According to Lai et al. (2002), both internal-facing and customer-facing measures are needed in order to arrive at a comprehensive view of supply chain performance in transport logistics. Although traditional buying criteria such as costs still dominate logistics services, the number of customer inquiries concerning the environmental performance of LSPs is increasing (Wolf & Seuring, 2010). Hence, environmental collaboration might be one way in which to differentiate and offer improved customer service. Future research could address this in incorporating customer-service performance as one sub-component of operational performance. Finally, given the results of this study indicating that the operational performance of LSPs is dependent on the share of the largest customer, perhaps environmental collaboration is not the right type of green supply chain practice on which to assess logistics service providers. The buyer of the logistics services might, in fact, largely dictate the green activities of the providers. Hence, environmental monitoring by the buyer could be a more appropriate construct with which to measure the environmental activities of LSPs, and thus an interesting future research area.

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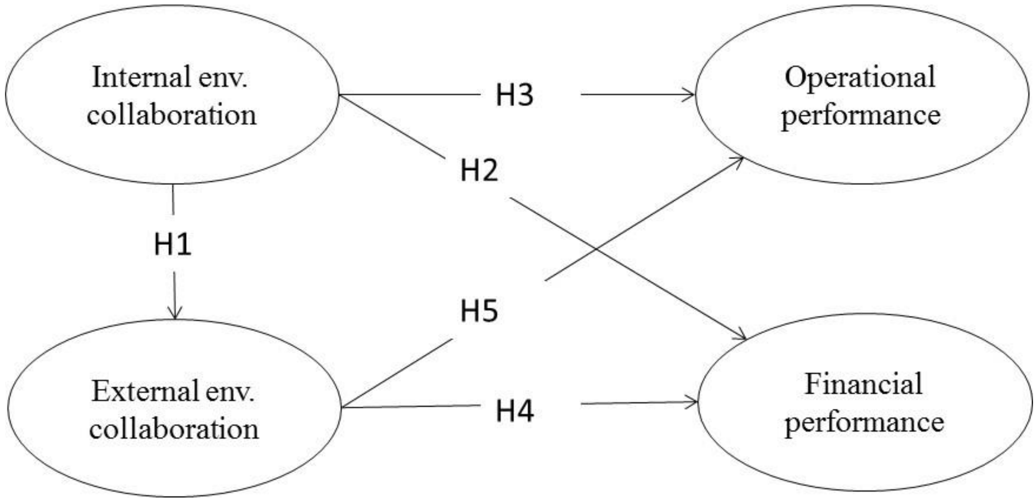

Figure 1. Key concepts and research hypotheses

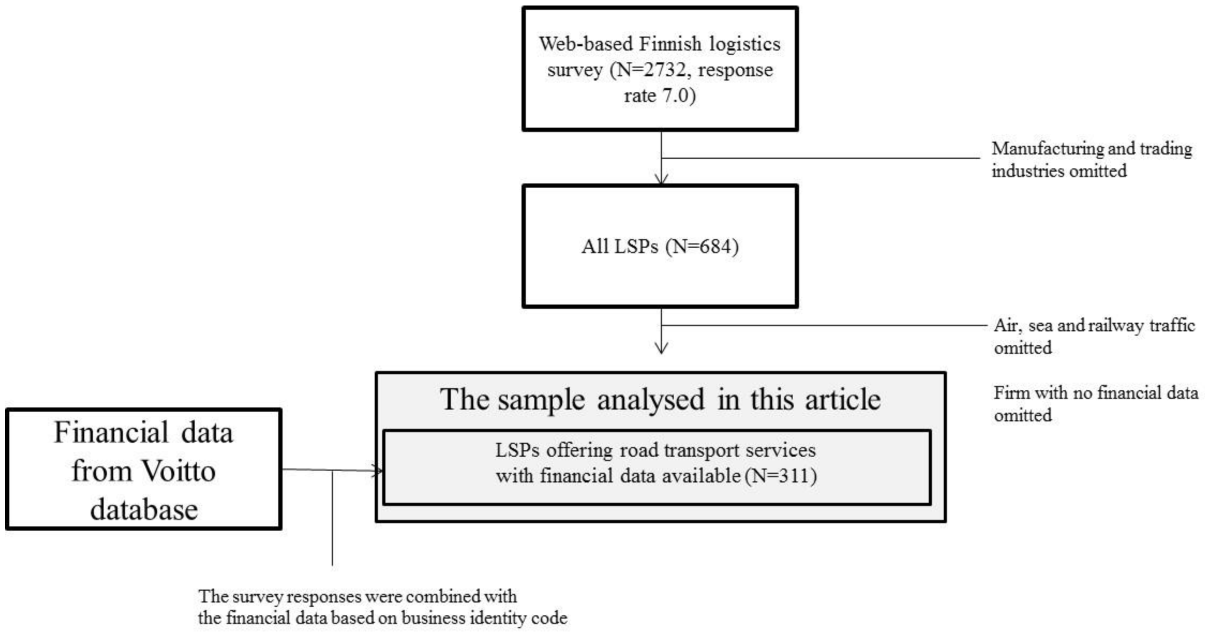

Figure 2. Data sources used in the study

Table I Measurement items

Internal environmental collaboration	
INT1	We have set environmental goals for ourselves
INT2	There is a mutual understanding of responsibilities regarding environmental performance
INT3	We have worked together to reduce the environmental impact of our activities
INT4	We have conducted joint planning to anticipate and solve environment-related problems
INT5	We have worked together to reduce the environmental impact of our products
Environmental collaboration with customers	
CUST1	We've worked together to achieve environmental goals collectively with our key customers
CUST2	There is a mutual understanding of responsibilities regarding environmental performance
CUST3	We have worked together to reduce the environmental impact of our activities
CUST4	We have conducted joint planning to anticipate and solve environment-related problems
CUST5	We have worked together to reduce the environmental impact of our products
Operational performance	
EMPTY	Empty mile percentage (%)
DOMESTIC	Average load factor (%) in domestic shipments
INTL	Average load factor (%) in international shipments
TRANSPERF	Average transport performance per vehicle (km)
LENGTH	Average length of haul (km)
Financial performance	
EBIT-%	Earnings Before Interest and Taxes (%)
ROI	Return on Investment
ROA	Return on Assets
Control variables	
SIZE	Firm size; 0= micro-sized company with a turnover from 0 to 2 million EUR , 1=small, medium or large company with turnover more than 2 million EUR
SINGLE	the single largest customer's share of turnover (%)
CHAIN	part of the value chain mainly served; 0=manufacturing, 1=trading

Table II Descriptive statistics of research variables

	Variable name	n	Mean	Med.	Std dev	Transformation	Distribution
Independent	INT	261	3.886	4.000	0.834		
Independent	EXT	244	3.376	3.333	1.010		
Dependent	EMPTY	247	0.468	0.447	0.176	Square root	Normal
Dependent	DOMESTIC	239	0.793	0.849	0.209	ε deducted	Beta
Dependent	INTL	100	0.726	0.899	0.317	ε deducted	Beta
Dependent	TRANSPERF	240	4.916	5.000	0.365	Logarithmic	Normal
Dependent	LENGTH	241	2.174	2.301	0.591	Logarithmic	Normal
Dependent	EBIT	311	0.032	0.028	0.116		Normal
Dependent	ROI	311	0.095	0.074	0.308		Normal
Dependent	ROA	311	0.069	0.056	0.180		Normal

Table III The results of the final CFA

Latent variables	Unstandardised factor loading	Completely standardised factor loading	t-value
Internal environmental collaboration			
α = 0.907, CR = 0.910, AVE = 0.719			
INT1	1.000	0.679	-[a]
INT3	1.179	0.800	12.987
INT4	1.241	0.843	13.316
INT5	1.189	0.807	12.299
Environmental collaboration with customers			
α = 0.932, CR = 0.945, AVE = 0.719			
CUST2	1.000	0.968	-[a]
CUST3	0.975	0.944	21.829
CUST5	0.992	0.961	20.358

[a] T-statistics for these parameters were not available because they were fixed for scaling purposes.

Fit indices: X^2= 27.810, X^2/df = 2.139, GFI = 0.964 , AGFI = 0.923 , CFI = 0.991, NFI = 0.983, IFI = 0.991, RMSEA = 0.074

Table IV Pearson correlations of the research variables

	INT[a]	EXT[a]	EMPTY	DOMESTIC	INTL	TRANSPERF	LENGTH	EBIT	ROI	ROA
INT[a]	1.000									
EXT[a]	0.610**	1.000								
EMPTY	0.006	0.124	1.000							
DOMESTIC	0.084	0.101	0.180**	1.000						
INTL	0.030	0.098	0.269**	0.512**	1.000					
TRANSPERF	-0.066	0.041	-0.015	0.232**	0.495**	1.000				
LENGTH	-0.093	-0.136	-0.196	0.035	0.424**	0.470**	1.000			
EBIT	0.013	0.105	-0.040	0.038	-0.168	0.064	-0.072	1.000		
ROI	-0.013	0.126*	-0.041	0.005	-0.047	-0.043	-0.037	0.636**	1.000	
ROA	0.016	0.135*	-0.013	0.033	-0.080	0.010	-0.075	0.847**	0.870**	1.000

* Correlation is significant at the 0.05 level ** Correlation is significant at the 0.01 level [a] Indicates an independent variable

Table V Model-based results

Dependent variable	Procedure	Distribution	Link function	Step	INTERNAL	EXTERNAL	SIZE	CHAIN	SINGLE	R^2	Adjusted R^2	BIC [a]	Observed statistical power
Operational performance													
Empty mile percentage	Reg	Normal		1			-0.010	-0.065**	0.000	0.033	0.015	..	0.788
				2	0.001		-0.010	-0.065**	0.000	0.033	0.009	..	0.743
				3	**-0.022**	**0.031**	**-0.007**	**-0.061****	**0.000**	**0.055**	**0.026**	..	**0.924**
Average transport performance per vehicle	Reg	Normal		**1**			**0.061**	**-0.087***	**0.003*****	**0.099**	**0.082**	..	**0.999**
				2	-0.013		0.064	-0.089*	0.003***	0.100	0.077	..	0.991
				3	-0.037	0.034	0.069	-0.085	0.003***	0.108	0.079	..	0.988
Average length of haul	Reg	Normal		1			0.290***	0.081	0.005***	0.076	0.059	..	0.994
				2	-0.053		0.301***	0.074	0.005***	0.081	0.058	..	0.994
				3	**-0.005**	**-0.063**	**0.296*****	**0.065**	**0.005*****	**0.089**	**0.060**	..	**0.995**
Average load factor in domestic shipments	Glimmix	Beta	Logit	**1**			**0.026**	**-0.590*****	**0.008*****	..	..	**-358.93**	..
				2	0.092		0.067	-0.630***	0.009***	..	..	-288.04	..
				3	-0.064	0.186*	0.158	-0.548***	0.008***	..	..	-243.98	..
Average load factor in international shipments	Glimmix	Beta	Logit	**1**			**0.274**	**-0.355**	**0.011****	..	..	**-140.61**	..
				2	0.143		0.351	-0.382	0.013***	..	..	-128.68	..
				3	0.140	0.065	0.384	-0.311	0.011**	..	..	-104.88	..
Financial performance													
EBIT	Reg	Normal		1			0.006	0.007	0.000	0.018	0.003	..	0.499
				2	0.007		0.004	0.008	0.000	0.021	0.001	..	0.519
				3	**-0.009**	**0.022****	**0.007**	**0.010**	**0.000**	**0.053**	**0.029**	..	**0.913**
ROI	Reg	Normal		1			0.039	-0.034	0.001*	0.019	0.004	..	0.523
				2	-0.008		0.041	-0.035	0.001*	0.020	0.000	..	0.497
				3	**-0.065****	**0.079*****	**0.052**	**-0.028**	**0.001**	**0.064**	**0.040**	..	**0.960**
ROA	Reg	Normal		1			0.016	-0.004	0.001**	0.027	0.012	..	0.692
				2	0.007		0.014	0.000	0.001*	0.028	0.008	..	0.660
				3	**-0.023**	**0.042*****	**0.020**	**0.000**	**0.001***	**0.070**	**0.045**	..	**0.975**

* significant at 0.1 level; ** significant at 0.05 level; *** significant at 0.01 level

[a] the smaller the better

Table VI The results of the hypotheses testing

Hypothesis	Outcome
H1. Internal EC → External EC (+)	Supported
H2a. Internal EC → EBIT % (+)	Not supported
H2b. Internal EC → ROI (+)	Not supported
H2c. Internal EC → ROA (+)	Not supported
H3a. Internal EC → Empty mile % (-)	Not supported
H3b. Internal EC → Transport performance (-)	Not supported
H3c. Internal EC → Length of haul (-)	Not supported
H3d. Internal EC → Load factor, domestic shipments (+)	Not supported
H3e. Internal EC → Load factor, international shipments (+)	Not supported
H4a. External EC → EBIT % (+)	Supported
H4b. External EC → ROI (+)	Supported
H4c. External EC → ROA (+)	Supported
H5a. External EC → Empty mile % (-)	Not supported
H5b. External EC → Transport performance (-)	Not supported
H5c. External EC → Length of haul (-)	Not supported
H5d. External EC → Load factor, domestic shipments (+)	Supported
H5e. External EC → Load factor, international shipments (+)	Not supported