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THE CONNECTION OF ENVIRONMENTAL COLLABORATION IN THE SUPPLY CHAIN AND TRANSPORTATION COSTS OF MANUFACTURING AND TRADING COMPANIES

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ABSTRACT

1. Objective
For a while, sustainability and environmental questions have been raising awareness. Customers are demanding environmentally friendly and sustainable products, and companies are trying to meet the demand. From the company side, environmental efforts of the companies can be seen in several ways. Some see them purely as additional costs in tightening competition, whereas some see them as an opportunity to create new, more competitive business. Transportation as one of the major contributors on the environmental footprint of the companies is in focus of this paper. Environmental collaboration of manufacturing and trading companies is analysed through their connection with transportation costs.

2. Data/Methodology
To identify the connections between the environmental collaboration and transportation costs self-reported survey data from the Finnish National Logistics Survey 2012 will be analysed. The sub-sample used will consist of 888 Finnish manufacturing and trading companies. In the analysis, three self-reported sets of variables on environmental collaboration in the supply chain are studied against self-reported transportation costs. The research methods used include descriptive analysis, ANOVA and generalized linear models.

3. Results/Findings
In the analysis we were able to identify significant connections between environmental collaboration of the companies and the level of transportation costs. It would seem that some of the companies are able to achieve benefits especially from collaborating with their customers and suppliers. On the other hand, some of the manufacturing companies operating on industries with low value added seem to experience higher costs with increasing environmental collaboration.

4. Implications for Research/Policy
Environmental efforts of the companies can't be seen just as an extra burden to the companies. Our results show that in fact some of the companies are able to reduce their costs by increasing their environmental efforts, in this case their co-operation with their customers and suppliers. Further research is needed to deepen the understanding of which ways of co-operation are most beneficial both environmentally and economically.

Keywords: transportation costs, environmental collaboration, manufacturing, trading

1. INTRODUCTION

Every company has an environmental footprint whether it is by producing goods and thereby causing emissions, waste etc., or simply by lighting and heating the store or production facilities. Transport generates a significant number of environmental effects. For example, in EU27 transport accounts for about 20 % of total greenhouse gas emissions (Eurostat 2012). Roughly 8 per cent of total CO_2 emissions were generated by freight transportation (McKinnon 2010). Different stakeholder groups, such as governmental agencies, neighbours, workers, non-profit organisations and some consumer segments are becoming increasingly aware of these impacts and demand environmentally friendly and sustainable products. Companies are striving for meeting this demand, and one way to do this is by collaborating in the supply chain. (Vachon & Klassen 2006.)

This paper examines the connection between environmental collaboration in the supply chain and the transportation costs of manufacturing and trading companies. Vachon and Klassen (2008) define environmental collaboration as "the direct involvement of an organization with its suppliers and customers in planning jointly for environmental management and environmental solutions". They conclude that environmental collaboration focuses more on the means by which more environmentally friendly operations and products can be achieved and less on the immediate outcome of the environmental efforts with customers or suppliers (e.g. compliance to regulations).

This article contributes to the on-going discussion on the connection between environmental management and economic performance by analysing the effect of environmental collaboration in the supply chain on transportation costs. Transportation costs of trading and manufacturing firms were chosen to be analysed because they are the largest logistics cost item, accounting for 4.6 per cent of sales in Finland in 2011 (Solakivi et al. 2012). Also, Wu et al. (1995) argue that transportation is the most important source of environmental hazards, making it one of the key issues in green supply chain management.

The rest of the paper is organized as follows: Section 2 introduces the concept of environmental collaboration through a literature review, Section 3 presents the research design, including the research questions and the used dataset. Section 4 presents the descriptive and model based results. In section 4 the findings are summarized and discussed.

2. LITERATURE REVIEW

Reasons to environmental efforts have been widely discussed in literature. The institutional theory highlights the role of social and cultural pressures imposed on organisations (Scott 1992). DiMaggio and Powell (1983) assert that there are three types of institutional mechanism affecting managerial decisions: coercive, mimetic and normative isomorphism i.e. processes that force organisations to resemble other organisations facing the same set of environmental conditions. Jennings and Zandbergen (1995) argue that coercive pressures, in the form of environmental regulations and regulatory enforcement, have been the main reason to adoption of environmental practices. However, several studies (e.g. Berry & Rondinelli 1998) argue that environmental management is evolving from regulatory-driven to more proactive. Firms are facing increasing market and competitive pressures from customers and competitors to produce more environmentally-friendly products. (Zhu & Sarkis 2007)

Another widely used approach to study environmental management is resource-based view (RBV). Its principal contribution is the theory of competitive advantage. It is founded on the assumption that certain firm-specific key resources are sources of sustained competitive advantage (Barney 1991). Resources can be tangible, such as financial reserves, and capital equipment, or intangible, such as skills of employees and firm reputation (Grant 1991). Hart (1995) extended resource-based view and developed natural-resource-based view (NRBV) in which strategy and competitive advantage rest upon capabilities facilitating environmentally sustainable economic activities.

Recently, the focus of environmental management has broadened from intra-firm perspective to include inter-firm activities in entire supply chain. As a result, the concept of green supply chain management (GSCM) has been gaining increasing interest among researchers and practitioners. GSCM is defined 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". (Srivastava 2007.) GSCM promotes efficiency and synergy among business partners, and helps to improve environmental performance, minimize waste and achieve cost savings (Rao & Holt 2005).

Environmental collaboration is also characterised by a good understanding of each partner's responsibilities and capabilities in terms of environmental management. Collaboration can be either vertical (with customers, internally, and with suppliers), or horizontal (with competitors, internally and with other, non-competitive organisations) (Barratt 2004, 32). In this paper we focus on vertical collaboration. Internal environmental management concerns firm-specific internal practices and does not involve business partners, while external environmental management consists of all joint environmental programs implemented by the supply chain partners (De Giovanni & Esposito-Vinzi 2012). Both internal and external environmental management are essential for implementing GSCM practices (Zhu et al 2008).

The benefits of supply chain collaboration seem to be evident in the literature. A number of strategic, tactical and operational level benefits are mentioned in the literature, e.g. increased flexibility and responsiveness leading to better customer service levels, better forecasting accuracy, lower inventory levels, shorter time to market, and higher product and delivery quality (e.g. Kahn and Mentzer 1996, Vonderembse & Tracey 1999, Biehl et al. 2006). However, relationship between environmental management and company performance is not so evident. The discrepancy of findings regarding the connection of environmental management and economic performance may be partly explained by the difficulty of evaluating environmental performance (Cohen et al. 1997). Even measuring supply chain performance has proved to be problematic (Beamon 1999a). For example Hervani et al. (2005) and Shaw et al. (2010) suggest incorporating environmental performance within the balanced scorecard. By doing that, firms identify environmental management as one of their strategic goals (Shaw et al. 2010). New measurement systems will help organisations remain competitive while maintaining sustainable processes (Beamon 1999b).

Several researchers (e.g. Rao & Holt 2005, Vachon & Klassen 2008) have studied the relationship between environmental performance and company performance. Some authors assume that environmental protection causes only additional costs (e.g. Mahapatra 1984), while others believe that companies can enhance their competitiveness by creating new, innovative products and business models (Porter & Reinhardt 2007). Alternatively, some studies argue that good economic performance is a prerequisite for environmental performance (Schaltegger & Synnestvedt 2002). Russo and Fouts (1997) tested the natural-resource-based theory and found that higher environmental performance is associated with higher financial performance. Rao and Holt (2005) state that greening inbound function (e.g. purchasing) and greening production leads to greening outbound function (e.g. distribution), as well as to competitiveness and economic performance of the firm. Vachon and Klassen

(2008) studied the effect of environmental collaboration on manufacturing performance. They found out that environmental performance was not significantly linked with cost performance, although it was positively linked with other dimensions of manufacturing performance, such as quality and flexibility. De Giovanni and Esposito-Vinzi (2012) came to similar conclusion: neither internal nor external environmental collaboration has a positive impact on economic performance. In conclusion, it would seem that internal environmental management is a prerequisite for external environmental collaboration but the economic impact of environmental efforts remains unclear.

3. RESEARCH DESIGN

3.1 Construct measurement

Environmental collaboration was evaluated by three sets of questions. Two sets of questions focusing on environmental collaboration with suppliers and customers were derived fromVachon and Klassen (2008). In addition, one set of questions reflecting the level of environmental collaboration within the company was included. The questions were asked as five-point likert-scale questions (1= totally agree, 5=totally agree).

The three elements of environmental collaboration were subjected to explorative factor analysis whose rotated solution is shown in Table 1. In the factor analysis, the elements loaded on two factors in a way that one of the factors contained all the items of internal collaboration, and the other factor contained all items of both the collaboration with the suppliers and also with the customers. This finding closely resembles previous research of Zhu, Sarkis and Lai (2013), who also concluded that environmental collaboration consist of two separate dimensions, internal collaboration and external collaboration. Two new variables, Internal (ranging from 5 to 25) and External (ranging from 10 to 50) were formed by calculating the sums of top loading variables. The new variables and their Cronbach's alphas are shown in Table 1.

Transportation costs were measured as a self-reported open ended question. The respondents wer asked to provide an estimate of transportation costs as a proportion of company turnover that, according to Stewart (1995), is a robust base for analysis.

Company size, measured as turnover was also controlled. In the survey, a rough estimate of company turnover was asked from the respondents. Based on these self-reported estimates, the companies were divided into four separate categories, derived from the European Commission's definition on small and medium sized enterprises. By definition, a company with turnover less than 2 million euro is considered a micro sized company, a company with the turnover of 2-10 million euro is considered a small company, a company with a turnover of 10-50 million euro is considered to be a medium-sized company and finally, a company with a turnover of over 50 million euro is considered to be a large company. The European

Commission's definition also includes elements related to number of employees and the balance of the company, but in this case only the turnover criteria was used.

Table 1: The results of factor analysis on measures of environmental collaboration, top loadings bolded

	1	2
We have set environmental goals to ourselves	0.31	**0.829**
There is a mutual understanding of responsibilities regarding environmental performance	0.365	**0.732**
We have worked together to reduce environmental impact of our activities	0.257	**0.867**
We have conducted joint planning to anticipate and solve environmental-related problems	0.392	**0.821**
We have worked together to reduce environmental impact of our products	0.327	**0.807**
We have goals to achieve environmental goals collectively with our key suppliers	**0.743**	0.407
There is a mutual understanding of responsibilities regarding environmental performance	**0.818**	0.318
We have worked together to reduce environmental impact of our activities	**0.836**	0.319
We have conducted joint planning to anticipate and solve environmental-related problems	**0.832**	0.348
We have worked together to reduce environmental impact of our products	**0.823**	0.346
We have goals to achieve environmental goals collectively with our key customers	**0.79**	0.351
There is a mutual of responsibilities regarding environmental performance	**0.835**	0.329
We have worked together to reduce environmental impact of our activities	**0.859**	0.302
We have conducted joint planning to anticipate and solve environmental-related problems	**0.854**	0.318
We have worked together to reduce environmental impact of our products	**0.849**	0.302
Cronbach's α	**0.97**	**0.92**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Kaiser-Meyer-Olkin Measure of Sampling Adequacy. 0,953 Bartlett's Test of Sphericity Approx. Chi-Square 17407,537 df 105 Sig. 0

Transportation costs of the manufacturing companies were also analysed using two other classifications. First, the manufacturing companies were divided on two categories based on **value added percentage**. The value added percentage was calculated by dividing the gross value added of the industry with the turnover of the industry. The industries were then divided into two, with one category representing the "high" value added percentage and the other category representing the "low" value added percentage. The division of the companies in value added categories is presented in appendix 1.

Second, the manufacturing companies were divided into two categories based on their **industry orientation**. The division was done, based on if the company belonged to a Finnish industry interest group "technology industry" or not. The "technology industry" is not an official industry classification, but a group of industries with common interest policy. From the analysis point of view this group is potentially interesting, since the industries themselves consider having common nominators in their operations and interest policy. The industries categorized as "technology industry" and "other" are presented in appendix 1.

3.2 Dataset

The empirical data analysed in this research consists of a sub-sample of the Finland State of Logistics 2012 survey. The research data was collected during January-February 2012, by the means of a web-based survey. An email invitation to participate was sent to 38834 persons, based on the following sample frame: all non-student members of the Finnish Association of Purchasing and Logistics (LOGY), members of Finnish Transport and Logistics association (SKAL), and members of Federation of Finnish Enterprises, active in the industries covered in the survey. In total, 2 732 responses were received, resulting in the response rate of 7.0% for the total survey. The relatively low response rate raises concerns of non-response bias, and the possibly low generalizability of the results. Wagner and Kemmerling (2010) analysed 229 articles in the field of logistics, compiling among other things the response rates of the surveys. Compared to the results of Wagner and Kemmerling (2010) the response rate of the Finland State of Logistics 2012, and similarly the response rate of this research is well in line with other surveys of similar scale.

The majority (78 %) of the respondents identified themselves as top management of the company, whereas the share of middle management was 8 % and the share of logistics experts 4 %. The remaining 10% of respondents represent other tasks in the supply chain.

For this particular research, however, we focused on a sub-sample including all the manufacturing and construction and trading companies that provided perfect responses for the questions. In total the sample consisted of 472 manufacturing and 416 trading companies. Duplicate answers per company were omitted from the data set.

The respondents represent a number of manufacturing industries, the most prominent ones in the dataset representing construction, manufacture of machinery and equipment and manufacture of fabricated metal products. The two largest groups of respondents from the trading industry represented categories of other specialized wholesale and retail trade. The aggregated turnover of the companies in the sample was 71.2 billion euro, which is approximately 27 % of the turnover of manufacturing and trading companies operating in

Finland, or over 50 % of the domestic turnover of Finnish manufacturing and trading industries. Overall, one can conclude that the sample used in this research covers a substantial part of the Finnish manufacturing and trading industries, which supports the generalizability of the results.

3.3 Distribution of dependent variable and used research method

In order to perform regression analysis, the normality of the distributions of the dependent and independent variables was investigated. Transportation costs were measured as a share of turnover. Generally, one could expect the share to range from 0 to 100 with a previously undetermined distribution function. Engblom et al. (2012) have stated that transportation costs and other components of logistics costs do not in fact follow the normal distribution, but instead the beta distribution. Dodd et al. (2006) argue that gamma distribution would be most suitable for the cost analysis.

Test of normality confirmed that the data on transportation costs was not normally distributed. Instead of normal distribution, the distribution of transportation costs resembled closely distributions in the tweedie family, more precisely the compound-Poisson distribution. Because of the non-normal distribution of the dependent variable, the ordinary–regression model was abandoned and the analysis was performed with generalized linear models. These models are all linear models where, where

$$\boldsymbol{Y} = \boldsymbol{\mu} + \boldsymbol{\varepsilon} \tag{1}$$

Linear dependency between dependent and independent variables is assumed through a link function (η) where

$$\eta(\boldsymbol{\mu}) = \boldsymbol{X\beta} \tag{2}$$

and X stands for independent variables and β slope estimates of the model. The starting model is (in scalar form):

$$\eta = \alpha_1 + \beta_1 INTERNAL_1 + \beta_2 EXTERNAL_2 \tag{3}$$

, where η represents the link function used in analysis and is model-dependent. In this research, a logarithmic link function was used. Independent variables INTERNAL and EXTERNAL refer to internal environmental collaboration and external environmental collaboration.

In addition to generalized linear models, descriptive statistics, t-test and ANOVA were used in the analyses.

4. RESULTS

4.1 Transportation costs

The transportation costs of the sample are on average some 7.54 per cent of turnover. There is a difference in the transportation costs between the manufacturing and trading companies; the transportation costs of manufacturing companies are on average 7.2 per cent of turnover, whereas the transportation costs of the trading companies are on average some 7.9 per cent of turnover. This difference was tested with t-statistics and turned out to be statistically insignificant. Table 2 presents the descriptive results of the transportation costs of manufacturing and trading companies of different sizes.

Table 2: Transportation costs of manufacturing and trading companies in different size categories

	Manufacturing		Trading	
	Mean	Std. Deviation	Mean	Std. Deviation
Micro	7.1	9.4	8.3	9.6
Small	8.2	11.1	6.0	12.3
Medium	7.4	6.3	7.6	6.1
Large	6.5	6.3	9.6	15.0

Despite the common view, there doesn't seem to be a clear trend, either rising or sinking, of the transportation costs and the company size. Among the manufacturing companies, the large companies would seem to have the lowest transportation costs, in average some 6.5 % of turnover, whereas among the trading companies the small companies would seem to have the lowest transportation costs. On the top end of the costs, the results are the opposite. Among the manufacturing companies, the small companies would seem to have the highest transportation costs, whereas among the trading companies, the highest transportation costs seem to be on the large companies.

The differences in transportation costs of companies in different size categories were also tested with ANOVA. None of the differences turned out to be statistically significant. In other words, based on our results one could conclude that companies are unable to enjoy significant economies of scale in transportation costs.

To further investigate the relationship between company size and the level of transportation costs, the survey data was combined with the accounting data. From the accounting data, the latest (2011) operating revenue was obtained. A regression analysis, with the transportation costs as the dependent variable and the 2011 operating revenue as independent was performed. The coefficients of the 2011 operating revenue turned out to be statistically insignificant, further confirming that there in fact is no significant connection between the company size and the level of transportation companies of the manufacturing and trading companies.

The transportation costs of the manufacturing companies in category “high” were on average 6.08 % of turnover, and the transportation costs of the companies in category “low” were on average 7.56 % of turnover. The t-test indicated that the difference between the two groups was statistically significant.

On average, the transportation costs of the companies included in “technology industry” were 5.85 per cent of turnover, whereas the transportation costs of the other companies were 7.97 per cent. The t-test indicated that also this difference was statistically significant.

4.2 Environmental collaboration

As presented before, environmental collaboration was measured with three five-item sets of questions, with scales from 1 to 5. Based on the factor analysis, the items were divided into two factors, which were then summed up to form two new variables, internal (environmental) collaboration and external (environmental) collaboration. The values of internal collaboration ranged from 5 to 25 (5 items with a scale from 1 to 5), and the values of external collaboration ranged from 10 to 50 (10 items with a scale from 10 to 50).

The possible differences between the main industries, company sizes and other previously mentioned variables on environmental collaboration were analysed.

Table 3: Averages of variables of internal and external collaboration among manufacturing and trading companies

	Manufacturing		Trading	
	Mean	Std. Deviation	Mean	Std. Deviation
Internal	18.47	4.93	18.12	5.24
External	31.84	10.23	30.64	10.75

On internal collaboration, the manufacturing companies had an average score of 18.47 and the trading companies a score of 18.12 (Table 3). On external collaboration, manufacturing companies had an average score of 31.84 and trading companies a score of 30.64. The averages are on the higher end of the scale, indicating that the companies do in fact collaborate on environmental issues, both within the company and with their customers and suppliers. According to the t-test the averages were not statistically significant. In other words, the manufacturing and trading companies collaborate equally extensively in environmental issues both within and outside the company.

Table 4: Averages of variables of internal and external collaboration among different size categories

	Internal		External	
	Mean	Std. Deviation	Mean	Std. Deviation
Micro	17.98	5.18	30.78	10.61
Small	18.25	4.84	31.06	10.20
Medium	19.68	4.03	32.05	9.67
Large	20.80	4.55	36.77	9.11

Company size, on the other hand, turned out to be statistically significant in determining the level of environmental collaboration (Table 4). Internal collaboration ranged from the average of micro-sized companies (17.98) to the average of large companies (20.80), whereas the external collaboration ranged from the average of micro-sized companies (30,78) to the average of large companies (36.77). The averages were tested with ANOVA. Based on the results, large companies collaborate internally significantly more than micro-sized companies and small companies. Also, medium sized companies collaborate internally more than micro-sized companies. On external collaboration a statistically significant difference was found between the large companies and the other size categories.

Table 5: Averages of variables of internal and external collaboration among companies with high and low value added percentage

	High		Low	
	Mean	Std. Deviation	Mean	Std. Deviation
Internal	19.37	5.1	18.12	4.9
External	31.47	10.56	31.79	10.35

Among the manufacturing companies, also the value added percentage was identified as an indicator to environmental collaboration (Table 5). The companies with high value added percentage had an average score of 19.37 on the internal collaboration, whereas the companies with low value added percentage had an average score of 18.12. On the external collaboration the "high" group had an average score of 31.47 and the "low" group had an average score of 31.79. The t-test indicated that the difference on internal collaboration between the "high" and "low" groups was statistically significant.

4.3 Connection of transport cost and environmental collaboration

Table 6 presents the model based results of the analysis. The first result is that internal environmental collaboration would seem to have no connection with the level of transportation costs. In the models, the coefficient of the internal collaboration turned out to be statistically insignificant. Collaboration with suppliers and customers on the other hand was significant in all the models. In addition, the connection between environmental collaboration and transportation costs would seem to be dependent on some of the background variables used in the analysis.

Table 6: The coefficients of the regression models

	Internal	External
Manufacturing		0.106**
Trading		-0.226**
High value added		-0.140**
Low value added		0.186**
Technology industry		0.094**
Other industries		0.100*

** significant on 0.05 level
* significant on 0.1 level

First of all, the signs of the coefficients for manufacturing and trading companies are different. The sign of the manufacturing companies indicates a positive relationship between the level of external environmental collaboration and transportation costs, whereas the sign of the trading companies indicates a negative connection. Even though a connection exists, one has to be careful in interpreting the results. If one also assumes causality, then one could conclude that trading companies are able to reduce their transportation costs by collaborating in environmental issues with their customers and suppliers, whereas the manufacturing companies are in fact harmed by environmental collaboration.

Based on the results, the companies operating in industries with high value added percentage seem to benefit from external environmental collaboration in form of lower transportation costs (coefficient -0.140), whereas the companies operating in industries with low value added percentage are harmed by it (coefficient 0.186). Industry orientation on the other hand would seem to affect less on the connection of environmental collaboration and transportation costs. The coefficients of technology industry and other industries are very close to each other, (0.094 and 0.1) and both positive.

5. SUMMARY AND CONCLUSIONS

In this paper the environmental collaboration and transportation costs were addressed through the analysis of a survey sample consisting of 472 manufacturing and 416 trading companies operating in Finland.

At the main industry level it would seem that there are no statistically significant differences between the level of transportation costs of the manufacturing and trading companies. Partly this can be said to be surprising, since usually the Finnish manufacturing companies have reported higher transportation costs than the trading companies. One of the explanations for the lack of difference could be that usually the large companies dominate the results, giving the big players of the concentrated Finnish retail trade with their highly developed supply chains much weight. In this analysis the SME's and even the micro-sized companies were included.

Our analysis of the effect of company size on the level of transportation costs seems to confuse this possibility even further. The descriptive statistics would indicate that the transportation costs of the large trading companies are even higher than of the smaller trading companies. The differences were tested both with ANOVA and regression analysis and none of them showed any significant connections between the company size and the level of transportation costs.

The transportation costs of the manufacturing companies were also tested using value added percentage of the industry and an interest group based categorization of the industry as background variable. The analysis revealed that, not surprisingly, the companies operating in industries with high value added percentage have on average lower transportation costs than the companies operating industries with low value added percentage. Also, the companies operating in industries representing interest group "technology industry" had lower transportation costs than the companies from the other industries.

As with the level of transportation costs, no significant differences between the environmental collaboration of manufacturing and trading companies could be identified. Size on the other hand was found to be a significant background variable in determining the level of environmental collaboration. Based on the results one could conclude that larger companies, especially the companies in category "large", do in fact collaborate quite extensively on environmental issues not only within the company, but also with their customers and suppliers. The results also indicate that within the manufacturing companies the companies operating in industries with high value added percentage collaborate more extensively in environmental questions than the companies in other industries.

The connection of environmental collaboration and the level of transportation costs was analysed using the same background variables as mentioned before. To simplify the analysis, an individual model was performed for all the background variables. The first result was that none of the models indicated any kind of connection between the internal environmental collaboration, and the level of transportation costs. The result can be interpreted in two ways.

One way is to interpret that companies do not achieve savings in transportation costs by collaborating internally in environmental issues. The other way to interpret this result is to highlight that in this analysis only the transportation costs were addressed. This doesn't rule out other possible achievements in cost savings or other performance indicators. These indicators need to be investigated in the future. The other way to interpret the result is to remind that the analysis did not reveal any negative effects on transportation costs. The analysis also ignored possible gains in environmental measures. In other words, one could conclude that by collaborating internally in environmental questions, the companies are not creating additional costs, at least in relation to transportation.

External environmental collaboration on the other hand turned out to be significantly connected to transportation costs. In some of the models, the connection was negative, in some cases positive. Based on these results one cannot claim that environmental collaboration with customers or suppliers is either beneficial or harmful to companies, but that it depends on the company.

First of all, based on our results, trading companies would seem to benefit from external environmental collaboration in form of lower transportation costs, whereas the manufacturing companies as a whole would seem to suffer from higher transportation costs while collaborating externally.

When analysing the manufacturing companies further, the results revealed that the manufacturing companies with high value added percentage were also able to achieve lower transportation costs by collaborating with their customers and suppliers, whereas the results were the opposite with the companies with low value added percentage.

For the companies, the results give different recommendations, based on the characteristics of the company. Internal collaboration would seem to have no positive effects on transportation costs. At the same time, it seems that the possible worries of rising costs are also unnecessary. If for example the stakeholder pressure is forcing towards environmental collaboration, the worry of rising costs seems unnecessary.

External collaboration would seem to depend more on the company characteristics. Trading companies and manufacturing companies on high value added industries could even benefit from collaborating with their customers and suppliers. Manufacturing companies on low value added industries on the other hand should proceed more cautiously towards further (environmental) collaboration. It could be that from the transportation cost perspective, the actions demand too much for too little.

While interpreting these results and recommendations, one has to keep in mind the limitations of this research, which simultaneously also make arguments for future research. Even though something could be said about the transportation costs, one should introduce the total cost concept and include other cost elements together with other performance indicators. Clearly, some actions may have positive effects on both environmental performance and company performance, whereas some other actions may force companies to trade-offs between different goals. Further research is needed to deepen the understanding, which actions best connect both the environmental and operational or financial goals of the company..

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Appendix 1. The classifications of manufacturing companies according to value added percentage and "technology industry" interest group participation

Industry	Frequency	Technology industry 1= Yes, 2=No	Value added percentage 1=High, 2=Low
Manufacture of food products, beverages and tobacco	31	2	2
Manufacture of textiles and textile products	7	2	1
Manufacture of leather and leather products	2	2	1
Manufacture of wood and wood products	23	2	2
Manufacture of pulp, paper and paper products; publishing and printing	5	2	2
Publishing, printing and reproduction of recorded media	11	2	1
Manufacture of chemicals, chemical products and man-made fibers	9	2	1
Manufacture of rubber and plastic products	10	2	2
Manufacture of other non-metallic mineral products	8	2	1
Manufacture of basic metals and fabricated metal products	82	1	2
Manufacture of machinery and equipment n.e.c.	57	1	2
Manufacture of electrical and optical equipment	17	1	1
Manufacture of transport equipment	7	1	2
Other manufacturing	49	2	1
Construction	154	2	2