LOGISTICS-PRODUCTION, LOGISTICS-MARKETING AND EXTERNAL INTEGRATION: THEIR IMPACT ON PERFORMANCE

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Abstract

Highly competitive environments are leading companies to implement Supply Chain Management (SCM) to improve performance and gain a competitive advantage. SCM involves integration, co-ordination and collaboration across organisations and throughout the supply chain. It means that SCM requires internal (intraorganisational) and external (interorganisational) integration.

This paper examines the Logistics-Production and Logistics-Marketing interfaces and their relation with the external integration process. The study also investigates the causal impact of these internal and external relationships on the company's logistical service performance.

To analyse this, an empirical study was conducted in the Spanish Fast Moving Consumer Goods (FMCG) sector.

Keywords
Logistics integration processes; Internal and external integration; Logistics performance

JEL codes: L290,L660,C120,C490

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1 Introduction

Interest in Supply Chain Management (SCM) has steadily increased since the 1980's, when firms saw the benefits that could be derived from its implementation. In the literature, we can find many authors who acknowledge that SCM can improve performance (See Shapiro, 1984; Ellram & Cooper, 1990; Cooper, 1993; Gustin, Stank & Daugherty, 1994; The Global Research Team at Michigan State University, 1995; Clark & Hammond, 1997; Christopher, 1998; and more recently Stank, Keller & Daugherty, 2001; and Gimenez & Ventura, 2002), but very few studies analyse it empirically (Stank, Keller & Daugherty, 2001; and Gimenez & Ventura, 2002).

SCM is *"the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders"* (Lambert, Cooper & Pagh, 1998). It follows that SCM involves integration, co-ordination and collaboration across organisations and throughout the supply chain. It means that SCM requires internal (intraorganisational) and external (interorganisational) integration.

Internal integration has to be studied within the firm's boundaries. It seeks to eliminate the traditional functional "silo approaches" and emphasize better coordination among functional areas. We follow Stock, Greis & Kasarda (1998) and measure the level of internal integration as the extent to which logistics activities interact with other functional areas. **External integration**, on the other hand, has to be studied along the supply chain: It is the integration of the logistics activities across firm boundaries (Stock, Greis & Kasarda, 1998).

How are firms approaching these integration processes? Stevens (1989) suggests that firms first integrate internally (coordinating Supply, Production and Distribution) and then, extend the integration to its supply chain members. We can find companies in different stages of this integration process: Some companies may have not initiated the integration process yet, others may have achieved internal integration by coordinating their logistics function with other functional areas; and, finally, there might be others that have extended the integration process to their supply chain members.

In this paper we analyse the integration process and the contribution of both levels of integration (internal and external) to improving firms' performance. We analyse the impact of internal integration by considering the interaction among three distinct but related areas: Logistics, Production and Marketing. We consider these areas for two reasons: first, the coordination between them is vital to produce and serve what customers demand, how and when they want. And, second, Logistics is an organizational function which shares responsibilities with Marketing and Production. Companies were traditionally organised according to two main areas: Production and Marketing, considering the rest as auxiliary or support functions. Before the existence of the integrated logistics concept (Supply-Production-Distribution), some of today's logistics responsibilities were under the Production or Marketing control. But, when Logistics appeared as an organizational function, some of the Marketing and Production's responsibilities were transferred to, or co-managed with the Logistics department. Figure 1 shows the activities of the Production, Logistics and Marketing functions. This figure also shows that some activities are in the intersections of Production-Logistics or Logistics-Marketing.

FIGURE 1. The Production, Logistics and Marketing functions

Production	Intersection of activities	Logistics	Intersection of activities	Marketing
• Plant's activity • Materials manipulation • Quality control • Maintenance	• Product planning • Plant location • Purchasing	• Transport • Inventory management • Warehousing	• Customer service • Packaging • Distribution channels • Information flow	• Promotion • Market research • Product mix • Price

Source: Adapted from **Casanovas, A. & Cuatrecasas, Ll. (2001)**: *Logística Empresarial*; Ed. Gestion 2000; Barcelona.

Regarding the external integration, we analyse its impact on performance according to its degree of implementation. For that purpose we examine two different manufacturer-retailer relationships for each company. Each of these two relationships attains a maximum and a minimum level of external integration respectively.

In the literature, the impact of cross-functional and cross-organizational integration on performance has been analysed from different perspectives. Ruekert & Walker (1987) and Parente, Pegels & Suresh (2002) analysed the Marketing-Production interface while Griffin & Hauser (1992), Céspedes (1994), Rho, Hahm & Yu (1994), Kahn (1996) and Liedtka (1996) concentrated on the Marketing / R&D integration. From the logistics point of view, we can classify the existing studies in three groups: those that analyse the relationship between internal integration and performance, those others that study the external integration and performance link, and those that consider the impact of both levels of integration on performance.

Among the ones that study the relationship between internal integration and performance we could mention the articles of Stank, Daugherty & Ellinger (2000) and Ellinger, Daugherty & Keller (2000), who analysed the impact of the Marketing/Logistics integration on distribution service performance.

With respect to the studies that analyse the impact of external integration upon performance we have to mention the following: Groves & Valsamakis (1998), Stank, Crum & Arango (1999), Stank, Daugherty & Autry (1999), Ellinger, Taylor & Daugherty (2000) and Scannell, Vickery & Dröge (2000). Groves & Valsamakis (1998) analysed the effect of relationships' management on firms' performance. Stank, Crum & Arango (1999) investigated the link between interfirm supply chain coordination and performance on key logistical elements. Stank, Daugherty & Autry (1999) analysed the association between Collaborative Planning Forecasting and Replenishment (CPFR) programs [1] and effectiveness in achieving operational performance goals. Ellinger, Taylor & Daugherty (2000) explored the relationship between the implementation of Automatic Replenishment Programs (ARP) [2] and firms' performance. And, finally, Scannell, Vickery & Dröge (2000) studied the relationship between supplier partnering, supplier development, JIT and firms' performance.

Finally, regarding the studies which consider the effect of both levels of integration (internal and external) we have to mention: Vargas, Cardenas & Matarranz (2000), Stank, Keller & Daugherty (2001) and Gimenez & Ventura (2002). Stank, Keller & Daugherty (2001) and Gimenez & Ventura (2002) explored the contribution of both levels of integration simultaneously, while Vargas, Cardenas & Matarranz (2000) considered both levels of integration independently.

Our study shares a similar framework to the studies of Stank, Keller & Daugherty (2001) and Gimenez & Ventura (2002), where internal and external integration are analysed simultaneously. But, our paper differs from the existing studies in some aspects: first, while most of the existing studies consider single departments or a general internal integration level without considering the interaction between departments, we consider such interaction. And second, while the existing studies (except Gimenez & Ventura, 2002) assign a unique degree of external integration to each company, we consider that companies usually strategically segment their relationships (Kraljic, 1983; Copacino, 1990; Anderson and Narus, 1991; Cooper and Gardner, 1993, Dyer, Cho and Chu, 1998; Tang, 1999, Masella and Rangone, 2000) and establish high collaborating relationships with some supply chain members and arm's length relationships with others.

2 Methodology

To examine the linkage between integration and logistical performance we designed a questionnaire with three sections, each one of them related to one construct: internal integration (Logistics-Marketing and Logistics-Production), external integration and performance.

In the internal integration part of the questionnaire we asked companies to measure the level of integration in two internal interfaces: Logistics-Marketing and Logistics-Production. The variables used to measure these integration levels are shown in table 1. They were defined from the literature (Stank, Daugherty & Ellinger, 2000 and Ellinger, Daugherty & Keller, 2000) and based on expert opinion to provide respondents with a common understanding of the questions.

Part two of the questionnaire was designed to measure the level of external integration. As companies usually strategically segment their relationships (Kraljic, 1983; Copacino, 1990;

Anderson and Narus, 1991; Cooper and Gardner, 1993, Dyer, Cho and Chu, 1998; Tang, 1999, Masella and Rangone, 2000), we decided to measure the level of integration in two manufacturer-retailer relationships: the most collaborating relationship and the least collaborating one. The variables used to measure these external integration levels are also shown in table 1. These variables were designed adapting the internal integration variables used by Stank, Daugherty & Ellinger (2000) and Ellinger, Daugherty & Keller (2000) to a supply chain relationship.

TABLE 1. Variables in the questionnaire

VARIABLES
Internal Integration (scale of 1 to 10)
II1 (IILP1 or IILM1): Informal teamwork
II2 (IILP2 or IILM2): Shared ideas, information and other resources
II3 (IILP3 or IILM3): Established teamwork
II4 (IILP4 or IILM4): Joint planning to anticipate and resolve operative problems
II5 (IILP5 or IILM5): Joint establishment of objectives
II6 (IILP6 or IILM6): Joint development of the responsibilities' understanding
II7 (IILP7 or IILM7): Joint decisions about ways to improve cost efficiencies
External Integration (scale of 1 to 10)
EI1: Informal teamwork
EI2: Shared information about sales forecasts, sales and stock levels
EI3: Joint development of logistics processes
EI4: Established work team for the implementation and development of continuous replenishment program (CRP) or other ECR practice
EI5: Joint planning to anticipate and resolve operative problems
EI6: Joint establishment of objectives
EI7: Joint development of the responsibilities' understanding
EI8: Joint decisions about ways to improve cost efficiencies
Absolute Performance (scale of 1 to 10)
AP1: My company has achieved a reduction in the cost-to-serve this customer
AP2: My company has achieved cost reductions in the transport to this customer
AP3: My company has achieved cost reductions in the order process of this customer
AP4: My company has achieved stock-out reductions in the products this customer buys
AP5: My company has achieved a lead time reduction for this customer

Performance variables are also shown in table 1. These variables were designed according to the literature and the results of an exploratory study (Gimenez, 2000), which showed that the benefits associated to Efficient Consumer Response (ECR) [3] were service improvements and costs and stock-outs reductions. As performance data was difficult to obtain because of the reticence of participants to give confidential data, performance in this study was operationalised by using senior management's perceptions of performance improvements. In order to analyse the integration-performance link, performance had to be related to the external integration level achieved in each relationship.

Questions were designed using a ten point Likert scale. The survey instrument was pre-tested at meetings with several experts, and, suggestions for rewording and repositioning were incorporated into the final survey instrument.

Potential participants were identified from a Spanish companies' database (Fomento de la Producción 25.000 database). Manufacturers from the food and perfumery-detergent sectors with a sales figure higher than 30 million euros were selected to make up the sample (199 companies).

As prenotification increases the response rate (Fox, Crask & Kim, 1988), all the companies in the sample were telephoned before mailing the questionnaire. We informed each company's Logistics or Supply Chain Director about the study, and only one company refused to participate in the survey. The 64 questionnaires received represent a 32,3% (64/198) response rate, which is considered very satisfactory, as potential participants were asked to provide sensitive and confidential data about their performance. Other similar studies have worked with a lower response rate; for example, Groves & Valsamakis (1998) achieved a response rate of 15%; Stank, Daugherty & Autry (1999) a 20,2%, and Stank, Keller & Daugherty (2001) a 11,5%.

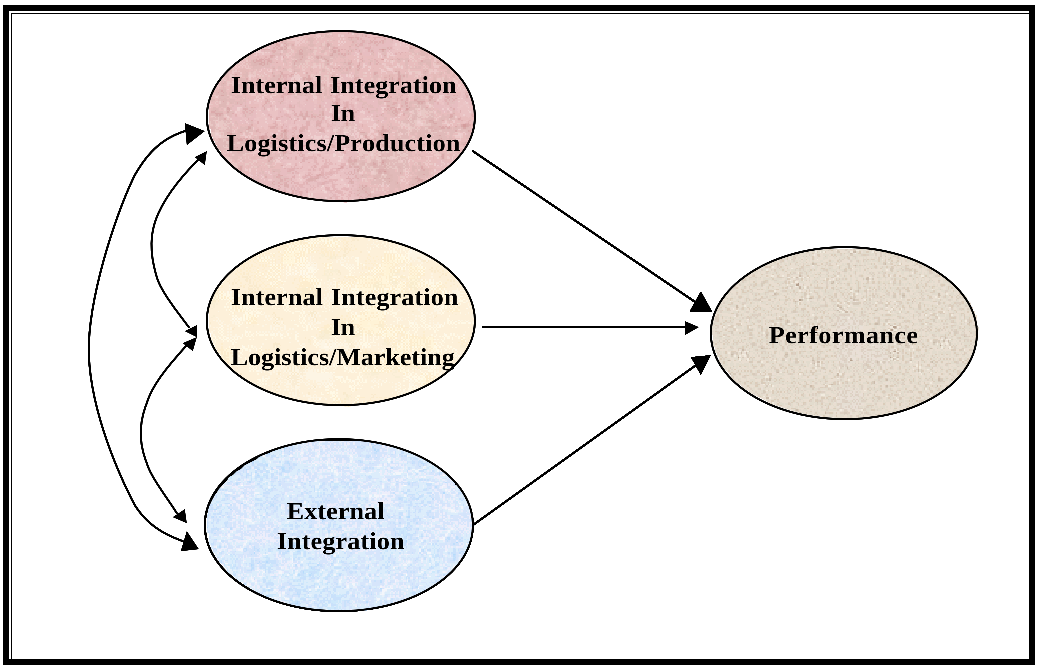
We conducted an analysis of non-response bias based on the procedure described by Armstrong & Overton (1977) and Lambert & Harrington (1990). We numbered the responses sequentially in the order they were received and compared late responses with early responses to all model variables using T-tests. We did not find any noticeable pattern among the variables that could indicate the existence of a non-response bias.

3 Model specification

The proposed structural model is shown in figure 2. There are four latent variables or factors: **internal integration in the Logistics-Production** interface, **internal integration in the Logistics-Marketing** interface, **external integration**, and firm's **performance**. Both internal integration and external integration affect firm's performance. Also, internal integration (in the Logistics-Production and Logistics-Marketing interfaces) is thought to be correlated among each other and with external integration.

These factors are not observed directly. Instead, we use several measurement variables as shown in Table 1. The complete model combines a construct part and a measurement part. It is a simple factor analysis model that can be easily estimated with a program such as EQS [4] (see Bentler, 1995).

FIGURE 2. Construct Model



The theoretical model illustrated in figure 2 was subjected to analysis using Structural Equation Modelling (SEM), which is a powerful statistical technique that combines the measurement model (confirmatory factor analysis) and the structural model (regression or path analysis) into a simultaneous statistical test.

4 Results

Tables 2 and 3 show the estimation results of the model. Table 2 reports the measurement part of the model. Table 3 displays the structural coefficients of the model, both the regression coefficients among the performance and the integration factors, and the variance-covariance structure of the integration variables. The estimation is based on Maximum Likelihood and Normal theory.

We estimated the model twice, with data from the strongest and the weakest collaborating relationship between each firm and its retailers. The first two numeric columns of tables 2 and 3 show the results for the strongest collaborating relationship, while the last two columns are computed from the data of the least collaborating one.

4.1 Measurement part of the model

In the logistics discipline, researchers are calling for future research to have a stronger theoretical foundation and to focus on theory testing research (Mentzer & Kahn, 1995; Mentzer & Flint, 1997 and Garver & Mentzer, 1999). To increase rigor in testing for construct validity, Garver & Mentzer (1999) pointed out that SEM is a very useful statistical instrument. Garver & Mentzer (1999) also advised performing and reporting all kinds of construct validity tests "to give the reader a greater level of confidence in the research findings". Following them, we performed some exploratory and confirmatory factor analysis before attempting the estimation of the complete model. Such analysis advised discarding the first proposed measure of internal integration in the Logistics-Production interface, since we detected two different factors associated with it. The rest of the measures were judged appropriate in the light of the results of most of the tests suggested by Garver and Mentzer. Those are reported in table A2, in the appendix.

Table 2 shows the loading coefficients between the factors and their respective measurement variables. To fix the scale, the loading of the first measure for each factor is set to one. The rest of the loading coefficients are always close to unity, and all of them are highly significant. Their values are very similar regardless of the fact that they have been estimated with data from the strongest or the weakest collaborating relationship.

TABLE 2. Measurement part of the model

Measurement part of the model				
	Most Collaborating Relationship		*Least Collaborating Relationship*	
Internal Integration	Factor Loading	Test Statistic	Factor Loading	Test Statistic
IIP2	1.000	---	1.000	---
IIP3	1.070	9.069	1.095	8.954
IIP4	1.275	7.841	1.271	7.854
IIP5	1.413	7.272	1.470	7.481
IIP6	1.333	8.143	1.341	8.206
IIP7	1.269	7.580	1.298	7.607
IIM1	1.000	---	1.000	---
IIM2	1.135	9.355	1.146	9.097
IIM3	1.188	8.998	1.158	8.889
IIM4	1.204	8.509	1.264	8.256
IIM5	1.293	8.455	1.287	8.228
IIM6	1.246	8.074	1.282	8.229
IIM7	0.923	4.934	1.076	7.395
External Integration				
EI1	1.00	---	1.00	---
EI2	1.310	6.188	0.992	5.799
EI3	1.485	7.239	1.142	5.897
EI4	1.263	5.679	1.019	5.918
EI5	1.397	7.177	1.237	7.177
EI6	1.410	4.302	0.879	5.353
EI7	1.460	6.809	1.054	6.224
EI8	1.555	7.347	1.076	5.889
Absolute Performance				
AP1	1.00	---	1.00	---
AP2	1.138	11.356	0.985	17.302
AP3	1.001	8.748	0.827	10.936
AP4	0.839	6.139	0.832	7.528
AP5	0.727	6.641	0.720	7.246

Next we describe the results for the construct part of the model.

4.2 Strongest relationship

Table 3 shows the structural coefficients of the direct relationship between the factors and their associated significance tests statistics. We also report the variance-covariance matrix of the factors and two measures of goodness of fit [5].

TABLE 3. Construct part of the model

Construct part of the model

	Most Collaborating Relationship			*Least Collaborating Relationship*		
	Construct Coefficients					
	Internal Integration LP	Internal Integration LM	External Integration	Internal Integration LP	Internal Integration LM	External Integration
Absolute Performance	0.245 (1.548)	-0.047 (-0.369)	0.727 (4.552)	0.543 (2.313)	0.083 (0.424)	0.665 (2.877)
Measures of fit						
Chi-square (d.f = 277)	442.74 (<0.001)			436.224 (<0.001)		
CFI	0.903			0.897		
	Factor variance-covariance matrix					
	Internal Integration LP	Internal Integration LM	External Integration	Internal Integration LP	Internal Integration LM	External Integration
Internal Integration LP	2.517 (3.441)	--	--	2.454 (3.447)	--	--
Internal Integration LM	1.566 (3.107)	3.144 (3.796)	--	1.668 (3.235)	3.147 (3.705)	--
External Integration	1.268 (2.784)	0.902 (2.007)	2.873 (3.112)	0.669 (2.056)	0.591 (1.681)	1.804 (3.108)

Note: Test statistics are inside the parenthesis. We report the probability values of the chi-square test and the ratio between the coefficient and its standard error for the estimates.

According to the CFI measure of fit, the model is accepted when estimated with data from the most collaborating relationship. All the variance and covariance figures among the integration factors are statistically significant. If we use them to compute the correlation ratios, we find that the correlation between the two internal integration factors is about 0.56, the correlation of external integration with internal integration in the Logistics-Production interface is about 0.47, and the correlation between external integration and internal integration in the Logistics-Marketing area is 0.30.

External integration has a positive and direct effect on performance. Internal integration does not. After taking into account the correlation among all the integration factors, we observe that internal integration (in either Logistics-Production or Logistics-Marketing) does not have any significant direct effect on performance when we consider the most collaborating relationship. External integration dominates the performance of the firm in the context of the most collaborating relationship with its retailers.

4.3 Weakest relationship

The results are different when we estimate the model with the data from the least collaborating relationship.

The fit of the model is a little worse, but very close to the acceptance boundary of 0.9. We observe now that the covariance between external integration and internal integration in the Logistics-Marketing interface is not statistically significant. The correlation among the two factors is 0.248, lower than before. Also, the covariance between internal integration in the Logistics-Production area and external integration is lower than in the case of the strongest relationship previously discussed, with a correlation estimate of 0.318. The variance of the external integration factor is also lower, indicating that all the companies in the data share a low and similar degree of external integration in their least collaborating relationships with their retailers. We also observe an interesting difference in the estimated structural regression coefficients. Now, internal integration in the Logistics-Production interface has a positive and significant effect on firm's performance. External integration still has a direct positive effect on performance, but such effect is weaker than before.

5 Conclusions

There are some generic results that can be derived from this analysis:

- There is a positive relationship between the Logistics-Production integration and external integration, being higher in the "most collaborating relationship" model. There is also a positive relationship between the level of integration in the Logistics-Marketing interface and the level of external integration, but it is marginally significant only for the "most collaborating relationship" model (it is not statistically significant for the "least collaborating" model). Despite the existence of these internal-external integration relationships, we cannot establish a causal relationship. These relationships have to be understood in the following way: internal integration is necessary for external integration, but internal integration does not imply external integration. In other words, firms follow the integration process proposed by Stevens (1989): firms first integrate internally and, then, extend the integration process to their supply chain members. However, this integration process is undertaken at different speeds: there are companies which are still not integrated, others that have only achieved internal integration, and some that have achieved internal and external integration.
- For the most collaborating relationships (in other words, externally integrated relationships), there is a higher correlation between Logistics-Production and external integration than between Logistics-Marketing and external integration. Also, a cluster analysis showed that there was not any externally integrated relationship in a company

not integrated in the Logistics-Production interface. However, this cluster analysis showed that there were externally integrated relationships in companies not integrated in the Logistics-Marketing interface. This shows that to achieve external integration companies need to be integrated in the Logistics-Production interface, while, interestingly, the integration between Logistics and Marketing is not a prerequisite.

- With respect to the impact of internal integration on performance, we have to distinguish between the Logistics-Marketing and Logistics-Production interfaces. When companies achieve a high level of internal integration in the Logistics-Marketing interface, this level of internal integration does not lead to a better absolute performance. A high level of collaboration among Logistics and Marketing processes does not contribute to achieving cost, stock-outs or lead time reductions. This is true for the most and the least collaborating models. However, when a firm achieves a high level of internal integration in the Logistics-Production interface, its effect on performance depends on whether there is, or is not, external integration. The level of Logistics-Production integration leads to a better absolute performance, in other words, it contributes to achieving cost, stock-outs and lead time reductions, when there is not external integration. However, when firms are externally integrated (for the most collaborating relationships), the level of external integration has such an important effect on performance that it annuls (or reduces) the effect of the Logistics-Production integration.
- External collaboration among supply chain members contributes to achieving costs, stock-outs and lead-time reductions. This is true for both models, the most and the least collaborating.
- The greatest influence on firms' logistical service performance is for external integration. However, for the least collaborating relationships, the internal Logistics-Production integration has also a high impact on distribution performance.

SCM is not easy to set-up: there can be internal barriers to change processes, and there can also be difficulties to shifting from traditional arms-length or even adversarial attitudes to a partnership perspective. However, support has been found for a relationship between firms' logistical performance and SCM.

With respect to the studies mentioned in the literature review, our results confirm that internal and external integration are correlated and that external integration leads to a better logistical performance. We add some contributions: we have shown that the impact on performance of internal integration depends on the functional areas that are being integrated and the level of external integration. When companies are not externally integrated, we have demonstrated that the Logistics-Production integration leads to a better absolute performance, while the Logistics-Marketing integration, interestingly, does not. However, when companies are externally integrated, the level of internal integration in any of the two internal interfaces does not have any impact on performance.

Our results differ from those obtained by Stank, Daugherty and Ellinger (2000), who found that companies with high levels of integration between Logistics and Marketing showed higher levels of logistical service performance (response to customer needs, response to special requirements and collaboration in new product launches). Further research on the Logistics-Marketing impact on performance should be carried out and other logistical service measures should be included in the performance construct. It would also be interesting to compare the impact of both internal integration levels (Logistics-Production and Logistics-Marketing) on performance in other industries, as the Logistics-Marketing interface may be more crucial in other sectors.

Finally, we have to mention that despite our findings, our study has some limitations. One of them is that we have not considered other important members of the grocery supply chain such as grocery retailers, Third Party Logistics, manufacturers' suppliers, etc. We have focused only on the manufacturer-retailer relationship from the manufacturer point of view. We have only considered the effect of inter-firm co-ordination from the perspective of the provider (as most studies do), while satisfaction with service performance should also be assessed from the customer perspective. To alleviate the concern about the biased performance assessment by providers, future research should collect data from both sides of the relationship.

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Appendix

TABLE A1. Sample characteristics

SAMPLE CHARACTERISTICS		
Sales volume (million €)		
More than 600	3	4,7%
401 – 600	1	1,6%
201 – 400	8	12,5%
101 – 200	24	37,5%
51 – 100	15	23,4%
30 - 50	13	20,3%
Sectors		
Chemicals - Perfumery and detergents	12	18,8%
Food - Fish and preserved products	6	9,4%
Food - Dairy products	5	7,8%
Food - Wheat	4	6,3%
Food - Dried fruit	2	3,1%
Food - Meats	5	7,8%
Food - Preserved vegetables	3	4,7%
Food - Drinks	15	23,4%
Food - Oils	4	6,3%
Food - Varied products	8	12,5%

TABLE A2: Confirmatory Factor Analysis

	Parameter Estimate	Test Statistic		Parameter Estimate	Test Statistic		Parameter Estimate	Test Statistic		Parameter Estimate	Test Statistic
IILP2	1.000	---	IILM1	1.000	---	IE1	1.000	---	RA1	1.000	---
IILP3	1.006	8.180	IILM2	1.211	8.160	IE2	1.219	6.859	RA2	1.115	12.419
IILP4	1.257	7.487	IILM3	1.226	8.020	IR3	1.413	8.316	RA3	0.951	9.266
IILP5	1.411	7.074	IILM4	1.251	7.577	IE4	1.208	6.501	RA4	0.688	5.444
IILP6	1.372	7.795	IILM5	1.318	7.660	IE5	1.343	8.361	RA5	0.752	7.957
IILP7	1.271	6.675	IILM6	1.311	7.572	IE6	1.372	7.329			
			IILM7	1.093	4.753	IE7	1.403	7.924			
						IE8	1.461	8.869			
CFI	c^2	**Cronbach's** a	**CFI**	c^2	**Cronbach's** a	**CFI**	c^2	**Cronbach's** a	**CFI**	c^2	**Cronbach's** a
0.991	10.773 (0.21491)	0.939	0.982	21.406 (0.09167)	0.935	1.000	13.068 (0.6678)	0.965	0.977	9.364 (0.05262)	0.912
Construct Reliability[a]	0.856		**Construct Reliability**	0.873		**Construct Reliability**	0.874		**Construct Reliability**	0.830	
Variance Extracted[b]	0.717		**Variance Extracted**	0.716		**Variance Extracted**	0.788		**Variance Extracted**	0.666	

[a] The SEM construct reliability formula is $\left(\sum l_j\right)^2 / \left[\left(\sum l_j\right)^2 + \sum\left(1 - l_j{}^2\right)\right]$ where l_j is the standardized parameter estimate between the latent variable and indicator j

[b] The SEM variance extracted formula is $\sum l_j{}^2 / \left[\sum l_j{}^2 + \sum\left(1 - l_j{}^2\right)\right]$. See Garver anf Mentzer (1999).

Table A.2 reports some of the results of a preliminary confirmatory factor analysis that we carried out separately on each measurement model. The measurement model of the internal integration factors is common to the two collaboration relationships that we considered. External integration and performance are different in each type of relationship. In this table we have chosen to report the results of the tests conducted with data proceeding from the most collaborating relationship. The results are very similar when we consider the less collaborating relationships.

Unidimensionality of the measurement model is assessed by examining the overall measurement model fit and the fit of its components. Although we report the c^{2} statistic fit tests and observe that their associated probability values reveal a very good fit of each model, we know that such statistic is too dependent on sample size and it is better to report alternative measures of fit, such as the Comparative Fit Index (CFI). The CFI reported in table A2 measures the fit of each latent variable's measurement model separately. All the values are greater than 0.9 and therefore we conclude that the individual measurement models fit well. When testing the overall measurement model, that is a model with the two internal integration latent variables and one external integration latent variable allowing all three variables to be correlated, the global CFI is 0.923. The correlation between the two internal integration factors is 0.57. The correlation between internal integration in the logistics production interface and external integration is 0.486, and between internal integration in the logistics marketing and external integration is 0.315. Modification indexes have been examined and significant correlations among measurement errors have been incorporated to the model. The standardised residuals for each model are all small. As seen in table A2, all the loadings have the right magnitude and direction and are all highly significant. Therefore validity is also confirmed.

As for scale reliability, we report three measures as suggested by Garver and Mentzer (1999). Table A2 shows the Cronbach's a (which is always bigger than the benchmark value of 0.9), the Construct Reliability test (which is always greater than the acceptance level of 0.7), and the Variance Extracted test (which is always bigger than 0.5 as it should).

End Notes:

[1]"CPFR involves collaborating and jointly planning to make long term projections which are constantly up-dated based on actual demand and market changes" (Stank, Daugherty & Autry, 1999).

[2] ARP can be identified as an external integration program. They have been implemented by many companies within the ECR philosophy. These programs provide a day-to-day guidance for replenishment. ARP is different from CPFR: because CPFR is based on long term planning. CPFR has been described as a step beyond efficient consumer response, i.e. automatic replenishment programs, because of the high level of co-operation and collaboration.

[3] ECR can be considered to be the sectorial implementation of SCM.

[4] There is plenty of other very good software in Structural Equations Modeling. See for example LISREL (Jöreskog & Sörbom, 1993), AMOS (Arbuckle, 1997), or CALIS (SAS Institute, 1990) among others.

[5] It is well know that the chi-square statistic is too dependent on sample size, and might be prone to rejection in many cases. Instead, the Comparative Fit Index (CFI) measure is a well-accepted alternative to ascertain the goodness of fit of the model.