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The impact of Upstream Integration on Companies' Performances

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***Abstract*— Research on supply chain management (SCM) highlights that the positive impact of supply chain integration on companies' performance is questionable. In particular, some authors pinpoint that it is fundamental studying the contextual factors that can influence the need for and success of integration practices. This paper focuses on upstream integration (UI) and the potential moderating effect of lead time reduction. Analyses based on a sample of 187 plants operating in mechanical, electronics and transportation equipment sectors, show that a positive relationship exists between UI and efficiency and schedule attainment performance, and that the impact of UI is positively moderated by short lead times.**

Keywords- supply chain management; hierarchical regression; moderating effects; integration

I. INTRODUCTION

In SCM literature, the dominant belief is that supply chain integration is an useful approach to improve various measures of firm performance [1]. This hangs on the notion that when the members of a supply network behave as a part of a unified system and coordinate with each other, several benefits can be reached in terms of cost reductions, inventories, order delays, customer satisfaction and profitability [2]. However, recent developments in SCM studies have questioned this assumption, and several doubts have been expressed on the positive impact of supply chain integration on companies' performance [3], [4], [5], [6]. In particular, some authors pinpoint that in certain conditions integration benefits can be offset by inefficiencies and abnormal behaviours [4], [6], and that it is fundamental studying the contextual factors that can influence the need for and success of integration practices [5] [7]. In other words, it could be argued that some contextual factors could act as moderators on the integration-performance relationship. A moderator variable affects the direction and/or the strength of a relation between an independent and dependent variable. This means that the impact of integration practices could be positively influenced by certain contextual conditions. However, empirical studies demonstrating the existence of these possible moderating effects are really scant.

This paper focuses on upstream integration (UI) and the potential moderating effect of lead time reduction. UI concerns the relationships that a firm maintains with its suppliers (e.g. supplier partnering, closer relationships) and the implementation of practices to coordinate buyer-supplier plans and decisions (e.g. shared information, open communication on problems that can occur etc.) [7]. According to SCM literature, lead times are a crucial factor that can amplify the impact of UI on companies' performance. If suppliers have long lead times, UI benefits for the companies are limited, as the supplier/production network is not able to respond to the signals from the market [8] [9].

Thus, the aim of this study is twofold. On the one hand, it intends to investigate whether UI positively affects performance, in particular efficiency and schedule attainment. On the other, in line with the recent developments in SCM field, this study aims to analyze whether lead time reduction positively moderates the relationship between UI and efficiency, and UI and schedule attainment.

II. RESEARCH HYPOTHESES

This research intends to investigate not only whether UI influences efficiency and schedule attainment performance, but also whether the effect of UI depends on the structure of the supplier network. In particular, does lead time reduction act as a moderator on UI-performance relationship? Consequently, we posit the following research hypotheses:

Hypothesis 1a: Upstream Integration is positively related to efficiency

Hypothesis 1b: Upstream Integration is positively related to schedule attainment

Hypothesis 2a: Short supplier lead times positively moderate the relationship between upstream integration and efficiency

Hypothesis 2b: Short supplier lead times positively moderate the relationship between upstream integration and schedule attainment

III. METHODS

A. Data Collection and Sample

This study uses data from the third round of the High Performance Manufacturing (HPM) project data set. Data were collected during the 2005-2007 timeframe by an international team of researchers working in different universities all over the world and include responses from manufacturing plants operating in mechanical, electronic and transportation equipment sectors and located in different countries: Finland, US, Japan, Germany, Sweden, Korea, Italy, Spain and Austria. The scales and objective items were

assigned to multiple questionnaires and distributed to multiple respondents. In total 20 informants were involved in each plant (plant manager, HR manager, Process Engineer, New product development manager, etc). In order to raise measurement reliability, each questionnaire was administered to different respondents within each plant. We asked to the CEOs (or to a research coordinator within each plant) to provide us the name and contact addresses of the respondents for each questionnaire, and to distribute to the respondents the questionnaires we provided to him/her by individual visits or by post. Within the research group, for each country, a group of researchers and a person in charge of data collection were identified. Each group had to provide assistance to the respondents, to ensure that the information gathered was both complete and correct.

The items used in the present research are a subset of the whole HPM survey and were targeted to upper management, i.e. plant managers, inventory managers and plant superintendents. Respondents within each plant were specifically asked to give answers on integration practices adopted with suppliers, supplier lead times, and performance obtained.

A total of 266 plants returned the questionnaires. Given the purpose of this study, 79 of these were discarded since they provided incomplete responses on the items of interest. Accordingly, the analysis that follows and all reported statistics were based on a sample of 187 plants. The sample is stratified to approximate equal distribution across all three sectors. The mean number of employees of the plants in the sample was 625.19 (number of hourly and salaried personnel). We use size (as well as industry) as a control variable later in the analysis to test whether this had any impact on efficiency and schedule-attainment performance.

B. Research Variables and Measures

Four multi-item constructs were considered in this paper, referred to as: Upstream Integration (UI), Lead Time Reduction (LTR), Efficiency (EFF) and Schedule Attainment Performance (SCH) (Table I).

Upstream Integration (UI). In SCM studies, several variations can be found in the way authors have tried to capture upstream integration [10]. The four items selected measure the integration between the producer and its suppliers, accounted for in the two key dimensions of integration reported above: cooperative relationships and integration practices. Respondents within the producer's company were asked to evaluate: information sharing on production plans, cooperative relationships held with suppliers, exchange of information on quality considerations and design changes, and the level of suppliers' engagement in improvement efforts.

TABLE I. MEASURES

Constructs	Items
Upstream Integration	We share our production plans with our suppliers.
	We maintain cooperative relationships with our suppliers.
	We maintain close communications with suppliers about quality considerations and design changes.
	We actively engage suppliers in our quality improvement efforts
Lead Time Reduction	We seek short lead times in the design of our supply chains.
	Our company strives to shorten supplier lead time, in order to avoid inventory and stockouts.
Efficiency	Indicate your opinion about how your plant compares to its competitors in your industry with regard to: unit cost of manufacturing
	Indicate your opinion about how your plant compares to its competitors in your industry with regard to: inventory turnover
Schedule Attainment	We usually meet the production schedule each day
	Our daily schedule is reasonable to complete on time
	We cannot adhere to our schedule on a daily basis
	It seems like we are always behind schedule

Lead Time Reduction (LTR). This is a two-item construct that measures to what extent companies 1) seek short lead times in the design of their supply chains, and 2) strive to shorten supplier lead time, in order to avoid inventory and stockouts [11].

Efficiency Performance (EFF). The two items considered in this scale measure: 1) the unit cost of manufacturing and 2) the inventory turnover. In accordance with several authors, since it is difficult to compare these measures in different industries, we decided to focus on perceptual and relative measures, by asking respondents to compare the performance of their plant with that of competitors.

Schedule attainment (SCH). It was captured via a multi-item scale that measures whether the plant usually satisfies and completes on time its production schedule [11].

The constructs UI, LTR and SCH were measured using multi-item perceptual scales, where values range from 1 ("strongly disagree") to 7 ("strongly agree"). With regard to the unit cost of manufacturing and the inventory turnover, we asked respondents to provide their opinion about the company's performance compared with that of its competitors on a 5 point Likert scale (from 1 indicating "poor, low" to 5 "superior").

In order to test the unidimensionality of the different constructs, a principal component factor analysis by Varimax rotation was implemented, and the reliability of scales was tested by measuring Cronbach's α. The eigenvalues of the initial extraction for four factors extracted exceed 1.0 and the percentage of variance explained ranges from 9.468% to 35.881%. The percentage of variance explained for all the rotated factors ranges from 13.096% to 21.856%.

The items comprising each construct have high factor loadings (i.e. more than 0.586), thus reflecting high construct validity. Further. the off-factor loadings for the other items comprising each factor are low (i.e. < 0.400), providing evidence of discriminant validity for the items. Finally, Cronbach α-values for the four constructs exceed 0.700, indicating high reliability [12].

IV. Data Analysis and Results

We employed a hierarchical regression procedure. Firstly, control variables (i.e. firm size and sector) were considered in the regression model. The firm size (SIZE) was measured by the number of company's employees. The sector was insert in the regression model, by creating dummy variables. The mechanical sector was arbitrarily taken as the baseline/comparison group.

Then, main independent variables - i.e. UI and LTR - were introduced as a block, followed by the interaction term, calculated by multiplying UI by LTR . To address the problem of multicollinearity, we follow the procedure recommended by several authors of centering the independent variables of the regression model [13].

Tables 3 and 4 report the result of the hierarchical regression analyses for the response variables: efficiency and schedule attainment, respectively.

Model 0 represents the first step of the hierarchical regression. The control variable 'Electronics' results significantly related to efficiency performance; while the control variables: 'Electronics' and 'Transportations Eq.' are both significantly related to schedule attainment. Also in the models 1 and 2 similar results on the effect of control variables on the response variables are found. More interestingly, when the independent variables: UI and LTR are added to the regression models (model 1), we can note that both are significantly and positively related to efficiency and schedule attainment performance. Finally, models 2 report the coefficient of the interaction term, along with changes occurring to main variables when this product term was introduced. In tables II and III, the significant and positive β of the interaction term suggests that it is possible to confirm the existence of a positive interaction effect between UI and LTR, on efficiency and schedule attainment.

TABLE II. Regression Analysis (Dep. Var= eff)

	MODEL 0	**MODEL 1**	**MODEL 2**
Constant	3.293***	3.335***	3.306***
ELECTRONICS	-0.255*	-0.301*	-0.306**
TRANSPORTATION EQ.	-0.024	-0.013	-0.016
SIZE	0.000**	0.000	9.17E-005
UI		0.244**	0.222*
LTR		0.243**	0.329***
UIxLTR			0.291*
R^2	0.073	0.187	0.217
R^2 Adjusted	0.056	0.161	0.187
Δ R^2 adjusted	----	0.105	0.026

TABLE III. Regression Analysis (Dep. Var= Sch)

	MODEL 0	**MODEL 1**	**MODEL 2**
Constant	4.575***	4.634***	4.610***
ELECTRONICS	0.379*	0.317*	0.312*
TRANSPORTATION EQ.	0.487**	0.502***	0.500***
SIZE	0.000	40.41E-005	30.16E-005
UI		0.343**	0.326**
LTR		0.338***	0.408***
UIxLTR			0.239*
R^2	0.086	0.237	0.251
R^2 Adjusted	0.069	0.213	0.222
Δ **R^2** adjusted	----	0.144	0.009

V. Conclusions

The present study can contribute to the advancement of theory in different ways. Firstly, by investigating the main effect of UI on companies' performance, it contributes to the ongoing debate on the positive effect of integration, by providing further evidence that acting on UI can be beneficial for companies. Moreover, by analyzing the moderating effect of lead time reduction, it suggests that when lead times are short, the effect of UI could be greater.

The potential implications for managers seem compelling. From a practitioner's perspective, it is useful to know whether lead time reduction interacts with UI. Integration/SCM activities are not cost free and supply chain managers have limited resources. If lead time reduction magnifies the effect of UI, they could better evaluate whether, given the current contextual conditions, it is opportune to focus all the efforts to strengthen the relationships with their suppliers, or to invest also in reducing lead times, thus exploiting the resulting synergistic effect on performance.

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