Managing inventories in global sourcing contexts: a contingency perspective

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Abstract

In recent years, companies have paid growing attention to supply chain management at a global level. However, an under investigated point is how companies in different contexts experience the effects of global sourcing and the outcomes from their investments in the supply chain. Based on a model proposed by Golini and Kalchschmidt (2010), the aim of this paper is to verify whether different companies - in terms of contingency variables - experience different impacts of globalization and supply chain management on the material inventory level. In this work several contingency variables were selected according to the literature i.e., size, product complexity, type of production, type of purchases, number of suppliers and number of suppliers per item. Results show that when considering groups of companies characterized by different contingent variables, the relationship between globalization, supply chain investment and material inventory level is valid only for some groups, while for others loses its significance.

Introduction

Driven by market standardization, openness of borders, improvements in transportation and communication technologies globalization has been an always more relevant phenomenon in the last decades. In order to exploit advantages of globalization (e.g. low cost labor, resources, access to new markets) and to respond to the increasing competition, companies have expanded more and more their supply chains beyond national barriers (Hülsmann et al., 2008; Skjott-Larsen and Schary, 2007).

In this paper we focus on global sourcing, defined as the purchases made by a plant outside its continent. While opening new facilities abroad can require relevant financial efforts, global sourcing is a strategy viable also to smaller companies and it is therefore more diffused (Quintens et al., 2005; Trent and Monczka, 2003). However, performing global sourcing effectively is all but simple. When taking into account intercontinental transactions, global sourcing is not much diffused and the effect on performance is not always positive (Cagliano et al., 2008; Trent and Monczka, 2003). Several studies actually that did not find any significant impact of global supply chains on companies' performance (Kotabe and Omura, 1989; Steinle and Schiele, 2008).

When globalizing the supply chain, one of the problem addressed is how to keep the inventories low. As a matter of fact, longer distances increase the consignment lead times and variability, thus companies might have to keep higher material inventories to avoid stock-outs and production stops, as confirmed by several studies about global sourcing (Han et al., 2008; Stratton and Warburton, 2006).

In order to limit this problem, companies can invest in supply chain management. Generally speaking, supply chain management means to find ways, often in collaboration with other actors in the chain - like suppliers - in order to make the supply chain more efficient and/or responsive (Fisher, 2003). One of the benefits is usually to reduce or better allocate inventories, as for example happens with just-in-time techniques (e.g.Adair-Heeley, 1988). However, this can be complicated when suppliers are far away, as sharing information and collaborating is usually more difficult or the conditions to operate in just-in-time, as for example physical proximity, are not met. As a consequence, other types of supply chain management investments are usually adopted in global sourcing contexts as: multiple supply sources (Minner, 2003); information sharing systems (Nassimbeni and Sartor, 2007; Trent and Monczka, 2003); internal standards and procedures (Quintens et al., 2006; Zeng, 2003).

In this literature stream, Golini and Kalchschmidt (2010) provided evidence that in the manufacturing industry it is possible to almost fully moderate the negative impact of global sourcing on material inventory level through supply chain management investments (SCMI).

In that work, authors considered three typologies of SCMI, namely: rethinking and restructuring supply strategy; implementing supplier development and vendor rating programs; increasing the level of coordination of planning decisions and flow of goods with suppliers including dedicated investments. All these SCMI have a beneficial effect on reducing the material inventory level, especially the improvement of coordination of planning decisions and flow of goods.

Nevertheless, there are several factors potentially affecting such result that should be considered. Of course, in the analysis of global supply chains, differences among industries and countries have been found (i.e. World Trade Organization, 2009). However, these results are not always useful to operatively manage global supply chains. As a consequence, we decided to extend these researches considering what is the effect of the company, production and purchasing characteristics.

This is a highly important topic for companies and research. Since implementing SCMI has usually a relevant cost, it is important to use them in the situations in which there is higher need and where these investments can be more effective.

Because of that, starting from the Golini and Kalchschmidt (2010) model, we aim to verify whether that model holds for different groups of companies defined on the basis of a set of literature-based contingencies. As detailed in the literature review, the selected contingencies can potentially affect not only the variables (i.e. global sourcing, SCMI and inventory level), but also their relationships. This is in line with Sousa and Voss (2008) who support a more systemic view over the contingency analysis in Operations Management. In particular, the identified contingent variables are: company size, product complexity, type of production, type of purchases and number of suppliers. Since these variables cannot be traced back to a unique grand theory, we consider this paper as an exploratory analysis, in line with other contributions performing similar contingency analyses (e.g. Shah and Ward, 2003)

Thus, the research question that we want to address is:

To which extent the relationships among global sourcing, SCM investments and inventory performance are influenced by size, type of production, type of purchases, product complexity and the number of suppliers?

As a side result, we will also verified whether the model proposed by Golini and Kalchschmidt (2010), based on data collected in 2005, still holds using data collected in 2009. This was useful to show whether it is still possible to reduce the impact of global sourcing on inventories through SCMI.

The remainder of the paper is therefore structured as follows. In the next section, the concept of global sourcing is described, the literature on the relationship between global sourcing and inventory levels is reported and the most relevant contingent variables and their effects are presented. Next, the research method is described and then empirical analysis. Subsequently, a proper discussion of the results is provided, and, finally, we draw conclusions and suggest potential future research.

Literature Review

Global sourcing, inventories and supply chain management

Global sourcing can provide several advantages to companies, mainly lower procurement prices, new technologies, knowledge or higher-quality products (Bozarth et al., 1998; Frear et al., 1992; Monczka and Trent, 1991; Nassimbeni and Sartor, 2007). However, also fiscal aspects (e.g. taxation or currency), trading agreements between countries, access to new markets, shorter product development processes and product life cycles, or even company image can be also motivating factors (Frear et al., 1992; Nassimbeni and Sartor, 2007).

On the other side, it is not always easy to exploit such benefits due to the difficulties that arise when sourcing globally (Dornier et al., 2008; Handfield, 1994; MacCarthy and Atthirawong, 2003). Geographical distances cause longer and more variable lead times as multiple means of transportation are used. Moreover, for efficiency sake (e.g. to fill containers), batches ordered from far away suppliers have to be larger than those from domestic suppliers. Furthermore, global sourcing carries specific issues related to a lower knowledge of the suppliers and possible infrastructural deficiencies in developing countries (Meixell and Gargeya, 2005). Finally than can be major risks of supply chain disruption, political instability in sourcing countries, exchange price fluctuations that can undermine global sourcing profitability (Carter and Vickery, 1989; Dornier et al., 2008).

Because of that, in a global sourcing setting, companies typically use inventories as a shield for supply variability and disruption (Hendricks and Singhal, 2005; Stratton and Warburton, 2006). This, however, can be particularly costly and hard to sustain, especially in periods of financial constraints (Guariglia, 1999). One way to overcome the problem is sharing inventory risk with suppliers (Lai et al., 2009) or, more in general, apply SCMI to reduce inventories (Krause et al., 1998; Tan, 2001; Watts and Hahn, 1993).

In literature, the SCMI identified as more beneficial for inventories reduction are those related to supply chain coordination. We can group such investments in two categories: information sharing and system coupling (e.g. Cagliano et al., 2003; Frohlich and Westbrook, 2001).

Information sharing regards exchanging information with suppliers about inventory levels, production plans, forecasts. This practice requires a standardization of the information technology infrastructure, so its adoption has been significantly fostered by the diffusion of Internet based tools (e.g Caniato et al., 2009). System coupling is reached by putting in place with suppliers processes like just-in-time (JIT), collaborative planning forecasting and replenishment, vendor managed inventory, in order to achieve faster flows of products with less inventory levels (e.g. Power, 2005).

Investments both in information sharing and system coupling aim at a better coordination of the material flows among suppliers and customers with beneficial effects on the inventories, also for global supply chains (Babbar and Prasad, 1998; Trent and Monczka, 2003). However, when suppliers are closer, it is easier to put in place such investments with higher pay-offs. For instance, JIT is based on frequent, fast deliveries and small batches, a condition that can be difficult to obtain in a global sourcing context (Handfield, 1994). Thus, even if it is possible to achieve efficiency through global JIT, this improvement cannot be compared to what can be gained at a domestic level (Das and Handfield, 1997). Because of that, information sharing is usually a practice more adopted than system coupling in global contexts (Trent and Monczka, 2003). However the further away suppliers are, the more difficult is to share information due to cultural and technological barriers and mutual trust (Hartmann et al., 2008; Ives and Jarvenpaa, 1991; Nassimbeni and Sartor, 2007).

Because of this general difficulty in performing supply chain coordination with global suppliers, several authors focused on the supply organization and strategy that a company should develop to perform global sourcing effectively.

First of all, we can analyze the supply organization and strategy. Some authors (e.g. Gelderman and Semeijn, 2006) found the adoption of Kraljic's purchasing portfolio approach beneficial to manage a global supply base. In particular, in order to reduce the complexity induced by global sourcing, companies try reduce the number of suppliers (e.g. Choi and Krause, 2006). On the other side, the risk associated with global supply chains (fluctuating exchange rates, supply disruptions, strikes or political issues, lead-time variability) can be reduced using multiple supply sources (Minner, 2003; Harda and Hannet, 2006), although companies must deal with a larger supply base.

Next, related to supply base reduction, there is the concept of supplier development (Ogden, 2006). When selecting few global strategic suppliers companies often put in place vendor rating and supplier development programs in order to establish a collaborative relationship with suppliers aimed at performance improvement.

An effective synthesis of these three areas of global SCMI (i.e. coordination, supply strategy and supplier development) is provided by Golini and Kalchschmidt (2010). The results of this paper provide evidence of a relevant negative impact of global sourcing on inventory performance that can be partially reduced through the adoption of proper SCMI. As a matter of fact, global sourcing companies that have invested in SCM have inventory levels comparable to that of local sourcing companies. However, global sourcing companies that have not invested in SCM have the worst inventory performance of the entire sample. In particular, even if coordination with suppliers shows the highest potential in reducing inventories, it is not much adopted in global sourcing contexts probably due to the difficulties in coordinating with far away suppliers. On the other side, investing on efficiently managing the supplier base (suppliers portfolio strategy, vendor rating, supplier development) shows a higher level of adoption in global sourcing contexts and effectiveness in reducing material inventory levels.

As already shown in the introduction, limited evidence is however provided regarding the extent to which this result is valid in general or whether only some kind of companies are affected by the mentioned relationships. Because of that, we performed a literature review to identify which can be the most relevant contingent variables to be taken into account.

Contingencies effect

In the literature review, we identified several contingent variables that can affect the variables under analysis (i.e. global sourcing, SCM investment, inventories) and their mutual relationships. These variables can be classified into product, company, production and purchasing characteristics.

Starting from the industry characteristics, we found product complexity as a relevant variable affecting sourcing decisions (Sharon and Eppinger, 2001). Product complexity can indeed have a twofold effect over sourcing globalization. The less complex the product is and the easier is to scout for and communicate with suppliers abroad (Perona and Miragliotta, 2004; Westhead et al., 2001). On the other side, when dealing with complex products (i.e. technologically intense) companies might be forced to look for suppliers abroad if they are not available at a local scale (Chung et al., 2004).

About company characteristics, company size is one of the most relevant variables identified by literature. In order to source globally and to invest in SCM, both financial and human resources are needed, therefore bigger companies can find it easier. However, there are studies proving that also smaller companies can have a considerable adoption of global sourcing even if they can miss the necessary resources to perform it effectively (Cagliano et al., 2008; Cavusgil, 1980; Lee and Whang, 2000; Quintens et al., 2005).

About production characteristics, literature considers the position of the decoupling point (Naylor et al., 1999; Olhager and Östlund, 1990). Companies operating in make-to-stock contexts can be more efficient in managing their material inventory and plan consignments. On the other side companies operating in make-to-order must be more reactive so either they are more integrated with suppliers or they have to keep higher inventory levels (Gunasekaran and Ngai, 2005).

Finally, as purchasing characteristics we identified as relevant the total number of suppliers, the average number of suppliers per item and the type of products purchased. Having many suppliers allows to keep suppliers in competition and avoid under-capacity issues, but can reduce suppliers' responsiveness (Choi and Krause, 2006; Handfield et al., 2000). Moreover especially in global sourcing contexts, where the risk of disruption is higher, it might be necessary to keep some local suppliers to cope with emergencies. On the other side, having few suppliers can allow to establish partnerships and supply chain integration programs more effectively (Choi and Krause, 2006). However, since the total number of suppliers can be related to the industry, we considered also the average number of suppliers per item as a proxy of the purchasing strategy. According to Kraljic (1983) companies should adopt a single, dual, parallel or multiple sourcing strategies according to the different product categories. Other contributions suggest to downsize the number of suppliers keeping 2-3 suppliers at most per item (Goffin et al., 1997; Ogden, 2006).

For what concern the type of products purchased, raw materials show specific characteristics different from purchasing components and sub-systems. First of all, raw materials have a lower degree of customization and usually are supplied by large multinational companies, so creating partnerships with these companies can be difficult and not always necessary. Given the low information complexity and specificity together with highly capable suppliers, the relationship with raw material suppliers is usually arm-length and based on price (Gereffi et al., 2005). This is also confirmed by Cagliano et al. (2003) who found that companies in the upstream part of the value chain tend to have a lower adoption of integration and eBusiness tools with suppliers.

As we have seen, there are several contingent factors that can affect at the same time global sourcing and SCMI with a complex possible outcome on the material inventory level. Because of that, we focused our attention on the relationships among global sourcing, SCMI and delivery performance under different contingent factors.

Research Method

Golini and Kalchschmidt (2010) have provided evidence of a complex relationship among global sourcing, SCM investments and inventories, but no evidence is provided regarding under which conditions this result holds. Thus, we followed two steps in this research:

- First of all, replicated Golini and Kalchschmidt (2010) analysis on a new sample so to check whether those results hold;
- second, we tested this model under the effect of different contingency variable, so to identify whether and how contingencies play a role.

Thus, this paper is exploratory in its nature since we aim at evaluating whether or not a contingency effect exists. In order to achieve the goals stated above, we analyzed the mentioned relationships by means of data collected from an international research project. In the following paragraphs the sample is described, measures for the considered variables are provided and details regarding the adopted analytical approach are given.

The sample

In order to investigate the above research questions, data were collected from the fifth edition of the International Manufacturing Strategy Survey (IMSS 5) collected in 2009. This project, originally launched by London Business School and Chalmers University of Technology, studies manufacturing and supply chain strategies within the assembly industry (ISIC 28–35 classification) through a detailed questionnaire administered simultaneously in many countries by local research groups. Responses were gathered in a unique global database (Lindberg et al., 1998).

The sample is described in Table 1. In particular 485 companies (out of the 677 of the global database) provided information for this research; companies are distributed along 19 different countries. Companies are mainly constituted of small companies (50.5% of the sample) but also medium and large companies are represented. Different industrial sectors from the assembly industry are considered, mainly from the manufacturing of fabricated metal products, machinery and equipment.

Table 1 – Descriptive statistics in terms of (a) country, (b) size, (c) industrial sector (ISIC codes)

(a)

Country	**N**	**%**	**Country**	**N**	**%**
Belgium	25	5.2	Japan	18	3.7
Brazil	29	6.0	Mexico	11	2.3
Canada	13	2.7	Netherlands	39	8.0
China	32	6.6	Portugal	7	1.4
Denmark	13	2.7	Spain	27	5.6
Estonia	19	3.9	Switzerland	29	6.0
Germany	29	6.0	Taiwan	25	5.2
Hungary	59	12.2	UK	9	1.9
Ireland	5	1.0	USA	55	11.3
Italy	41	8.5	**Total**	**485**	**100**

(b)

Size*	**N**	**%**
Small	245	50.5
Medium	84	17.3
Large	156	32.2
Total	**485**	**100**

(c)

ISIC**	**N**	**%**
28	159	32.8
29	135	27.8
30	7	1.4
31	55	11.3
32	24	4.9
33	25	5.2
34	29	6.0
35	19	3.9
NA	32	6.6
Total	**485**	**100**

* Size**:** Small: less than 250 employees, Medium: 251-500 employees, Large: over 501 employees
**ISIC Code (Rev. 3.1): 28: Manufacture of fabricated metal products, except machinery and equipment; 29: Manufacture of machinery and equipment not classified elsewhere; 30: Manufacture of office, accounting, and computing machinery; 31: Manufacture of electrical machinery and apparatus not classified elsewhere; 32:Manufacture of radio, television, and communication equipment and apparatus; 33 Manufacture of medical, precision, and optical instruments, watches and clocks; 34: Manufacture of motor vehicles, trailers, and semi-trailers; 35:Manufacture of other transport equipment

Measures

To measure the extent of the globalization of sourcing activities, we collected information regarding the percentage of purchases outside the continent where the plant was based.

Because we were interested in the impact of sourcing on inventories, we took into consideration the raw material and components inventory levels. We measured material inventory level (MIL) in terms of days of production (on average) that are carried in the raw material/components inventory.

To measure supply chain management investments (SCMI), we defined a latent variable based on three items available in the questionnaire. These are single items which cover the three main areas of global SCMI identified in the literature, i.e. coordination, supply strategy and supplier development. Going into the detail of these items, companies were asked to provide information regarding their degree of use over the previous three years of the following action programs (in 1-5 Likert scale):

- Coordination: increasing the level of coordination of planning decisions and flow of goods with suppliers including dedicated investments (e.g. information systems, dedicated capacity/tools/ equipment, dedicated workforce);
- Supply strategy: rethinking and restructuring supply strategy and the organization and management of supplier portfolio through e.g. tiered networks, bundled outsourcing, and supply base reduction;
- Supplier development: implementing supplier development and vendor rating programs.

Given their high correlations[1], we considered these items into a unique SCMI construct. Its reliability is supported by a Cronbach's alpha of 0.769 and by high factor loadings (see Table 4).

The descriptive statistics for all the variables are shown in Table 2. SCMI is calculated as the average of the three items described above. We can see that companies purchase about 15% of their total spending globally, but that half of the companies purchase 5% or less globally, indicating a very left-skewed distribution. This confirms the low level of diffusion of global sourcing that other contributions have previously identified (Cagliano et al., 2008; Trent and Monczka, 2003). Considering inventory levels, we can see that companies have 27 days of stock on average but that half of these companies keep less than 15 days. In the end, SCMI (that range from 1 to 5) has an average adoption of 2.84 and they are quite symmetrically distributed.

Table 2 - Descriptive statistics for inventory level, global sourcing and SCMI

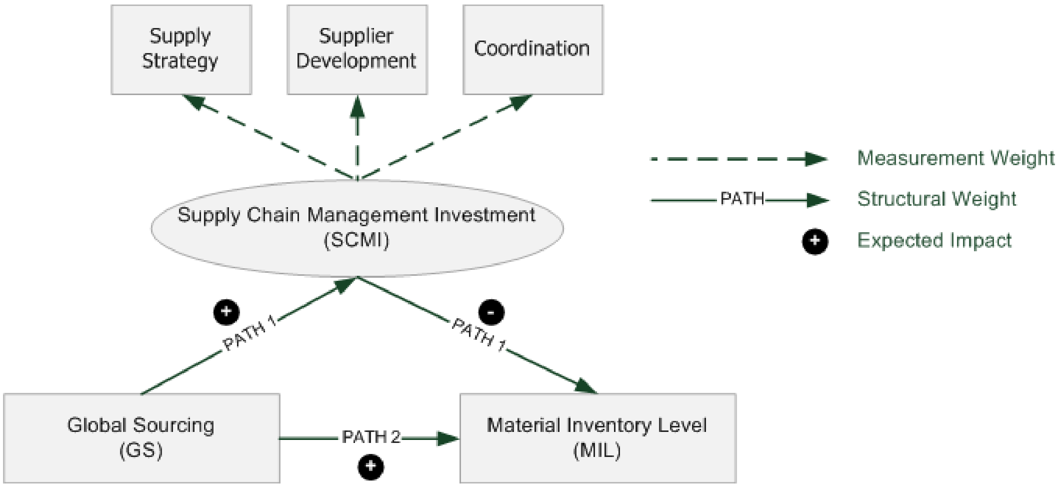
	Measure	Mean	Median	Std. Deviation	Minimum	Maximum
Material inventory level	n. of days of production	27.52	15.00	31.343	0	220
Global sourcing	% purchasing out of region	14.66	5.00	20.876	0	100
SCMI*	1-5	2.94	3	0.914	1	5
* Calculated as the average of: coordination, supplier development, supply strategy						

We considered these variables inside a structural equation model (Figure 1 and Figure 2 in Appendix) that replicates the one by Golini and Kalchschmidt (2010).

From left to right we can identify two paths from Global Sourcing (GS) to Material Inventory Level (MLI). Following Path 2, GS should increase the MIL (direct effect). Following Path 1, GS should positively affect Supply Chain Management Investments (SCMI) that in turn should reduce MIL (indirect effect).

[1] Supply Strategy – Supplier development: Pearson Correlation: 0.536 (sig. 2-tailed: 0.000)
Supply Strategy – Coordination: Pearson Correlation: 0.475 (sig. 2-tailed: 0.000)
Supplier development – Coordination: Pearson Correlation: 0.567 (sig. 2-tailed: 0.000)

Figure 1 - Structural model. Squares are observed variables, ovals latent variables. +/- is the expected impact of one variable on the other. Thin and dotted arrows represent measurement weights (factors) while bold arrows are structural weights.



We tested this model for the overall sample to check whether the hypothesized relationships are verified and which the total effect of GS on MIL is, considering the joint effect along the two paths.

Next we defined groups of companies facing different contingent contexts in terms of size, type of production, type of purchases, product complexity, total number of suppliers, average supplier per item.

Size was measured by means on the total number of employees and companies were divided according to whether they were SME (Group 1 – less than 250 employees) or large companies (Group 2 – more than 250 employees).

The type of production was evaluated by means of the percentage of orders managed according to either an ETO or MTO or ATO or MTS production system. If the orders managed in ETO or MTO were more than 50% we assigned that company to Group 1 while if the orders in ATO or MTS were the majority we assigned that company to Group 2.

About the type of purchases, we put in Group 1 companies purchasing raw materials for more than 50% of their spending and in Group 2 all the others (i.e. they spend more than 50% for parts/components, subassemblies/systems).

For what concerns product complexity, we defined a new variable as the mean of four 1-5 Likert-scale based items: type of product design (modular or integrated); type of product (component or finished product); number of parts/components (few or many); number of production phases (few or many). Summing these items together was justifiable as the factor's Cronbach’s alpha is equal to 0.72. By averaging these items we obtained a new variable ranging from 1 to 5 and we set 3.5 as a threshold discriminating low (Group 1) from high (Group 2) complexity products. We set 3.5 as a threshold in order to have Group 1 with more 200 companies given the statistical analysis performed after.

We defined 100 as the threshold number of suppliers to separate Group 1 and Group 2. This threshold was decided from one side because of the statistical purposes and from the other because 100 is typically considered a high number of suppliers for a supplier base (Christy and Grout, 1994; Goffin et al., 1997). In this way we could identify in Group 2 those who do actually have a very broad supplier base.

Since the total number of suppliers can be dependent on the type of industry, we also considered the average number of suppliers per item. Here we set at 2 the threshold since this is the median value and, in this way, we could discriminate companies pursuing a single/dual/parallel sourcing versus a multiple sourcing.

Table 3 summarizes the defined groups characteristics.

Table 3 - Groups definition for the different contingent factors (in brackets the number of companies for each group)

	Group 1	**Group 2**
Size	Number of employees < 250 (255)	Number of employees >=250 (284)
Type of production	Production mainly based on ETO or MTO (351)	Production mainly based on ATO or MTS (179)
Type of purchases	Raw materials are more than 50% of the total purchases (280)	Parts/components, subassemblies/systems are more than 50% of the total purchases (247)
Product complexity	<3.5 (203)	>=3.5 (343)
Total number of suppliers	<100 (233)	>=100 (253)
Average number of suppliers per item	<=2 (252)	>2 (195)

After that, we assessed the impact of contingencies on the model variables (GS, MIL, SCMI) by measuring differences between groups through a Mann-Whitney test (i.e. a non-parametric two independent samples test).

Finally, we performed a multiple-group analysis on the original model to assess differences between groups in the structural weights - the linkages among the main variables. We adopted a procedure similar to that one described in Arbuckle (2005), Cook et al. (2006), Tausch (2007). The procedure consists of the following four steps:

1. Configural equivalence: check if the model holds when the groups are considered separately, i.e. to establish whether the factor structure and the model is valid for the different groups. To do this, no constrain is set among groups.
2. Measurement equivalence: check if factor loadings are invariant among groups, i.e. establish whether groups perceive factors in the same way. To do this, an equality constrains is set on the measurement weights of different groups (see Figure 1 for measurement weights).
3. If the previous steps have a positive outcome, we analyzed differences among structural weights (see Figure 1) keeping the equality constraints among measurement weights. In this way we could assess differences among groups on the relationships (structural weights) among variables.
4. Finally, we checked how much the total effect of GS on MIL for different groups is.

Results

Overall model

As explained in the Methodology section, first of all we run the model by considering the whole sample and we found that the model holds (Table 4 provides a summary of the model fit). Since variables are non normal (see Table 10 in appendix), we validated results through Bollen-Stine p-value based on a 2,000 iterations bootstrap procedure.

Table 4 – Model fit statistics for the overall model

	chi-square	df	p-value	Bollen-Stine p-value	NFI	RMSEA	CFI
Default model	5.053	4	0.282	0.348	0.989	0.022	0.998

*NFI: Normed Fit Index (good above 0.95)
**RMSEA: Root Mean Squared Error of Approximation (good below 0.05)
CFI: Comparative fit index: close to 1 means very good fit

In Table 5 we can see that the factor loadings have positive and high factor scores (i.e. greater than 0.5) and that all the structural weights are all significant over 5% of confidence. In particular, the hypothesized relationships turned out to be confirmed: GS is associated to higher MIL by a standard estimate of 0.097 (direct effect). However GS is related to a higher adoption of SCMI by 0.162 that in turn lowers MIL by - 0.137 (indirect effect).

Table 5 – Estimates of the overall model

Relationship			Estimate	Std. Estimate	P
GS	→	MIL	.145	.097	.025
GS	→	SCMI	.006	.162	.000
SCMI	→	MIL	-5.501	-.137	.005
SCMI	→	Coordination	1.000	.712	-
SCMI	→	Supply strategy	.943	.668	.000
SCMI	→	Supplier development	1.147	.798	.000

In conclusion, thanks to the mediation effect of SCMI, the total effect of GS on MLI is 0.075 (while the direct was 0.097). These results confirm those obtained in Golini and Kalchschmidt (2010); table 6 provides a direct comparison of direct and indirect effects in the two works.

Table 6 - Direct, indirect and total effect of global sourcing on material inventory level in (Golini and Kalchschmidt, 2010) and this paper

	Standardized Estimate (Golini and Kalchschmidt, 2010)	Standardized Estimate (this paper)
Direct effect	0.094	0.097
Indirect effect	-0.026	-0.025
Total effect	**0.068**	**0.075**

Multi-group analysis

After the overall model assessment, we measured the impact of contingencies on the model variables (GS, MIL, SCMI) by measuring differences between groups through an independent sample Mann-Whitney test (the equivalent of a t-test for non parametric data). Results are reported in Table 7.

Table 7- Average values for different groups for the main model variables (values in bold identify a significant difference between groups with sig. < 0.05 assessed by a Mann-Whitney test).

Variable	Size		Type of purchases		Type of production		Product Complexity		Number of suppliers		Avg. suppliers per item	
	1	2	1	2	1	2	1	2	1	2	1	2
MIL	26.63	28.57	28.28	26.83	27.95	27.98	26.46	28.15	26.32	28.66	26,76	26,24
GS	**11.02**	**17.99**	**12.79**	**16.59**	**11.75**	**20.76**	**11.06**	**16.82**	**12.70**	**16.03**	**16,45**	**11,61**
SCMI	**2.67**	**3.17**	**2.81**	**3.08**	**2.87**	**3.08**	**2.76**	**3.05**	**2.83**	**3.09**	2.91	2.96

We can see that MIL is never significantly different among groups while the level of GS is always higher for each group 2. Specifically, our sample shows that companies adopting global sourcing are typically large companies, adopting ATO/MTS production systems, copying with relevant costs of purchasing, high product complexity and with several suppliers (both in absolute terms and relatively). SCMI are adopted more by companies in groups 2. The only exception is companies with many and few suppliers per item that do not show significant differences on SCMI.

After that, as explained in the methodology, we assessed configural and measurement equivalence. Models used to assess equivalence have always (i.e. for any contingency variable considered) a good fit that tends to increase when constraining measurement weights. Specifically RMSEA is always lower that 0.05, NFI is higher than 0.975 and CFI is higher than 0.990 (in appendix Table 11 provides details on measures of fit) This result is confirmed also by a bootstrap analysis (Bollen-Stine p-value) to overcome possible non-normality issues. By means of a chi-square test, we assessed that the increase in the fit is significant, meaning that considering measurement weights to be identical among groups improves the fit of the model. In conclusion, the model and the factors hold for different groups for all the contingencies and we moved to analyze differences in the structural weights.

Using the models constrained on the measurement weights to be identical, we finally compared regression coefficients between groups (Table 8).

Table 8 - Standardized structural weights for the overall model and the different groups (in bold the regression coefficients with sig. < .05 are highlighted)

		GS -> MIL		**GS -> SCMI**		**SCMI -> MIL**	
		Std. Est	**Sig.**	**Std. Est**	**Sig.**	**Std. Est**	**Sig.**
Overall model		**.097**	**.025**	**.162**	**.000**	**-.137**	**.005**
Size	Group 1	.004	.952	.088	.216	-.126	.080
	Group 2	**.153**	**.009**	**.135**	**.047**	**-.169**	**.013**
Type of production	Group 1	.078	.146	.088	.141	-.043	.474
	Group 2	**.164**	**.031**	**.268**	**.002**	**-.318**	**.000**
Type of purchases	Group 1	**.167**	**.005**	**.152**	**.024**	**-.197**	**.003**
	Group 2	.041	.519	.124	.090	-.082	.268
Product Complexity	Group 1	.069	.325	.095	.253	**-.209**	**.013**
	Group 2	.100	.066	**.156**	**.010**	-.110	.070
Number of suppliers	Group 1	**.131**	**.044**	**.149**	**.041**	**-.214**	**.004**
	Group 2	.103	.102	.078	.282	-.115	.116
Avg. Number of suppliers	Group 1	.051	.427	**.173**	**.015**	**-.157**	**.028**
	Group 2	**.176**	**.013**	.111	.174	**-.181**	**.027**

As we can see, the estimates are always significant only for:

- large companies (size - group 2);
- ATO/MTS companies (production – group 2);
- companies with less than 100 suppliers (number of suppliers – group 1);
- high raw materials share purchasers (type of purchases – group 1).

We can notice that for these groups the structural weights are higher than those calculated for the overall sample, meaning that GS has a stronger negative impact on MIL, but GS induces a higher adoption of SCMI and that SCMI has an higher potential in reducing MIL (for ATO/MTS companies in particular).

For the other cases relationships are never significant, meaning that it is not possible to relate GS to a higher adoption of SCMI or to higher MIL.

Looking at complexity, we find that relationships are only partially confirmed for both groups. Low complexity companies (group 1) have a positive reduction of their MIL thanks to SCMI, but global sourcing is not related to these variables. High complexity companies, instead, tend to have higher SCMI caused by higher GS but the impact on MIL is not significant.

Similarly, companies that tend to use few suppliers per item (i.e. single or dual sourcing) tend to have a higher adoption of SCMI when GS increases. On the contrary, companies that use several suppliers per item have a significant and positive impact of GS on MIL. Quite interestingly in both groups SCMI significantly decreases MIL but its effect is stronger for companies that have several suppliers per item.

Finally we analyzed the total effect of GS on MIL (Table 9). We can see that overall effect, when significant, is always positive even if it shows differences among the considered contingencies. In the next section these results are discussed.

Table 9– Total standardized effect of globalization investment on delivery performance (in bold are marked only groups for which structural weights were all significant in Table 8)

Model	Group	Total effect of GS on MIL
Overall model		**.075**
Size	Group 1	-.007
	Group 2	**.131**
Type of production	Group 1	.074
	Group 2	**.079**
Type of purchases	Group 1	**.137**
	Group 2	.031
Product complexity	Group 1	.078
	Group 2	.071
Number of Suppliers	Group 1	**.099**
	Group 2	.094
Avg. Number of suppliers	Group 1	.023
	Group 2	.156

Discussion

The empirical analyses provide interesting insights regarding the complex relationships among global sourcing, supply chain investments and material inventories.

First of all, results provided in Golini and Kalchschmidt (2010) are confirmed, thus the replication of the study confirms that the impact of global sourcing on material inventory level is mediated by supply chain management investments that, at least partially, reduce the negative effect of global sourcing (i.e., increase of material inventory level). The provided statistics confirm also the intensity of the relationships (see Table 5). Replication is an important part of the scientific process (Frohlich and Westbrook, 2001): theory-building must be followed by rounds of verification and elaboration (Flynn et al., 1990). In particular, a fast evolving issue, such as globalization, needs to be monitored to test the robustness of initial findings and eventually to identify evolutionary trends.

Second, the impact of the analyzed contingencies seems to be relevant. Quite interestingly the overall impact of contingencies is somehow peculiar: the theoretical model is valid only in some contexts. Thus, we cannot conclude that relationships vary for different companies but that the overall model is valid only under certain circumstances. In particular, the mentioned relationships are confirmed only in some conditions, specifically for larger companies, for companies with a limited number of suppliers, for companies characterized by ATO/MTS production processes and when purchases are mainly for raw materials. Quite interestingly the model is not completely significant when product complexity and average suppliers per item are considered. Discussion of these results is provided in the following.

Company size

The model is verified and significant only for larger firms - i.e. with more than 250 employees. This means that within small and medium enterprises various conditions can be found thus not allowing the model to be confirmed. Larger firms tend to adopt global sourcing and SCMI more than smaller firms and the impact of these variables on materials inventory level is stronger for larger companies. The total effect of global sourcing on material inventory level (see Table 9) confirms this result. This consequence is also related to the capabilities that larger firms may have of copying with higher inventories and their financial implications.

Type of production

Again, the model is verified only for one group - i.e., companies based on ATO/MTS production systems. In this case, the impact of supply chain investments is very high (std. estimate is -.318) also considering the strong impact of global sourcing on inventory level. Companies based on ATO/MTS production systems have to pay particular attention to inventory levels also due to the relevant implications of out of stock situations. For this reason, these companies tend also to invest more on the supply chain (see Table 7). This is also due to the higher adoption of global sourcing that characterizes these companies.

Type of purchases

The model is significant only for companies that buy mainly raw materials. The impact of global sourcing on inventory level is high (std. estimate is +.167), thus these companies tend to use global sourcing less than companies mainly buying parts and components (see Table 7).

Product complexity

In this case the model is not completely verified. Even if companies with different product complexity adopt differently global sourcing and supply chain investments (see Table 7) the relationships among the considered variables are not completely verified. In particular for companies facing contexts where simple products are managed and manufactured, the only significant relationship is between supply chain investments and inventory levels, while companies with higher product complexity show a significant relationship between global sourcing and supply chain investments. These results suggest further investigation in how global sourcing is adopted in contexts characterized by different product complexity.

Number of suppliers

The model is verified only for companies with a limited number of suppliers - i.e. less than 100 suppliers. For these companies the impact of supply chain investments on inventory level is very high (std. estimate is -.214). This means that when only a limited number of suppliers is adopted companies can more easily leverage on SCMI. The total effect of global sourcing on inventory level, even if still positive, is lower than the case for larger firms. This result is particularly interesting since SCMI are not significantly different between the two groups of companies (see Table 7).

Average number of suppliers per item

As for complexity, in this case the model is not completely verified. Even if companies with different numbers of suppliers per item adopt differently global sourcing (see Table 7) the relationships among the considered variables are not completely verified. In particular, for companies with few suppliers per item, we found significant relationships between global sourcing and SCMI and between SCMI and inventory levels, but no significant relationship exists between global sourcing and inventory levels. On the contrary companies with several suppliers per item show a significant relationship between global sourcing and inventory levels and between SCMI and inventory levels, but no relationship between global sourcing and supply chain investment.

Conclusions

This paper contributes to the research on the impact of globalization on companies operations. Specifically attention is here devoted on the mediation effect of supply chain investment on the relationship between global sourcing and material inventory level. The paper provides evidence that the impact of global sourcing on inventory level is mediated by supply chain management investments, but that its effect is strongly affected by the context companies are facing. Specifically, the identified relationships are confirmed only for larger companies, for companies with a limited number of suppliers, for companies characterized by ATO/MTS production processes and when purchases are mainly for raw materials. The paper thus provides an original contribution to current literature on the impact of globalization (and specifically global sourcing) on companies performance (i.e., material inventory level).

Besides, the paper provides evidence of the specific conditions under which companies should pay more attention to supply chain management investments to keep inventory levels under control in a global sourcing condition. The paper also indentifies that in some contexts the relationships among the mentioned variables are not clear and this suggests future research to explore in deeper detail these conditions.

In the end, we would like to highlight some of the limitations of the work. First of all, this work contributes to the vast debate on the role of supply chain investments in improving companies performance. However, supply chain investments imply costs and frequently higher managerial complexity, for this reason companies may be not willing to spend significant effort specifically when the cost-benefit trade-off is not positive. In this work we did not consider the costs that supply chain management may imply, and thus future works should address this topic directly. Second, our dataset includes companies only from the manufacturing industry, even if the ISIC code range is relatively wide. Anyway different outcomes could be found in other types of industries. Moreover only some contingency variables were considered: attention was paid to contingency variables that are considered as relevant global sourcing literature. Other variables may be significant and thus exploratory research would important to identify other relevant contingent factors. Next contingent variables can be correlated among them, e.g. a higher complexity product could be related to a higher number of suppliers, so this could be taken into account in following studies. Finally, the overall model (i.e. not discriminating between groups) holds: this means that there can be some complex compensating effects when putting together the companies that might need further investigations.

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Appendix

Figure 2 – Structural equation model

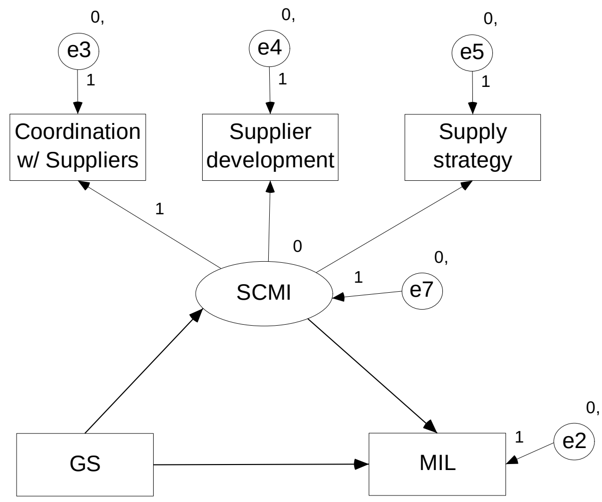

Table 10 – Skewness and kurtosis (a ratio higher than 2 or lower than – 2 is considered a significant departure from a normal distribution, while higher than 10 or lower than -10 is considered a severe non-normality)

Variable	skew	c.r.	kurtosis	c.r.
G1ca	1.863	17.786	3.017	14.404
SC9b	-.061	-.584	-.769	-3.671
SC9c	-.118	-1.124	-.908	-4.334
SC9a	-.141	-1.346	-.814	-3.887
PC3a	2.528	24.136	8.421	40.202

Table 11 – Configural and measurement equivalence models fit.

	chi-square	df	p-value	Bollen-Stine p-value	RMSEA	NFI	CFI
Size							
Configural equivalence	8.696	8	.369	.452	.000	.980	.998
Measurement equivalence	8.893	10	.542	.608	.000	.979	1.000
Type of production							
Configural equivalence	7.542	8	.479	.584	.000	.984	1.000
Measurement equivalence	8.838	10	.548	.635	.000	.981	1.000
Type of purchases							
Configural equivalence	7.357	8	.499	.595	.000	.984	1.000
Measurement equivalence	9.793	10	.459	.575	.000	.978	1.000
Product Complexity							
Configural equivalence	5.993	8	.648	.692	.000	.987	1.000
Measurement equivalence	6.896	10	.735	.782	.000	.985	1.000
Number of Suppliers							
Configural equivalence	7.935	8	.440	.514	.000	.980	1.000
Measurement equivalence	9.986	10	.442	.505	.000	.975	1.000
Avg. Number of suppliers							
Configural equivalence	8.420	8	.394	.423	.011	.979	.999
Measurement equivalence	13.902	10	.178	.217	.030	.966	.990