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The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships

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Abstract

This study examines the performance implications of an integrated supply chain strategy, with customer service performance followed by financial performance as performance constructs. Two major components of an integrated supply chain strategy are identified and defined: (1) integrative information technologies, which is modeled antecedent to (2) supply chain integration. The research model was tested using data from a sample ($n = 57$) of the top 150 independent first tier automotive suppliers to the Big 3 in North America. The results showed positive *direct* relationships between (1) integrated information technologies and supply chain integration, (2) supply chain integration and customer service, and (3) customer service and firm performance. The relationship of supply chain integration to financial performance was *indirect*, through customer service; i.e., customer service was found to fully (as opposed to partially) mediate the relationship between supply chain integration and firm performance for first tier suppliers in the automotive industry.

Keywords: Supply chain management; Supply chain integration; Customer service performance; Financial performance; Structural equations modeling

1. Introduction

Supply chain management takes a holistic perspective regarding the various activities, functions, and systems required to bring a product or service to market: it advocates that the supply chain be strategically managed as a single entity or system in contrast to individually optimizing fragmented segments or subsystems. This requires the integration of activities, functions, and systems throughout the supply chain. An integrative supply chain strategy recognizes that *integrated business processes* (not individual functions or systems) create value for the firm's customers and that these processes reach beyond the boundaries of the firm by drawing suppliers and customers into the value creation process (see e.g., Stevens, 1989; Tan et al., 1998).

The theoretical foundation for supply chain integration can be traced to the Value Chain Model (Porter, 1980, 1985), and specifically, its notion of linkages. A "linkage" is the relationship between the way in which one value activity is performed and the cost or

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performance of another. Porter advocated the identification and strategic exploitation of linkages *within* a firm's value chain (i.e., *horizontal* linkages) and *between* the firm's value chain and the value chains of its suppliers and customers (i.e., *vertical* linkages). Optimizing linkages amongst value activities, and in particular, optimizing vertical linkages, is the core purpose of supply chain integration. Such integration should engender superior performance (e.g., Tan et al., 1998; Frohlich and Westbrook, 2001).

A growing body of literature has suggested that the higher the degree of integration across the supply chain, the better a firm performs (see e.g., Stevens, 1989; Lee et al., 1997; Metters, 1997; Narasimhan and Jayaram, 1998; Lummus et al., 1998; Anderson and Katz, 1998; Hines et al., 1998; Johnson, 1999; Frohlich and Westbrook, 2001). At the same time, other literature has highlighted the dangers of not fully integrating suppliers and customers into a firm's business processes (Lee and Billington, 1992; Hammel and Kopczak, 1993; Armistead and Mapes, 1993; Frohlich and Westbrook, 2001). Most empirical studies have focused on either *upstream* integration or *downstream* integration, each to the exclusion of the other as pointed out by Eloranta and Hameri (1991). However, Frohlich and Westbrook (2001) recently examined upstream and downstream integration *simultaneously*. In this study, the widest "arc of integration" encompassing *both* suppliers and customers had the strongest association with performance improvement. While their findings add to the empirical support in the literature for a "supply chain integration–performance" link, their study tested for differences in mean levels of performance improvement for various levels of integration, and hence did not examine the specific form of the integration–performance relationship.

This research examines relationships existing among an integrative supply chain strategy, customer service, and overall firm performance. Two major dimensions of an integrative supply chain strategy are identified and defined from relevant literature: (1) integrative information technologies; and (2) supply chain integration. We view the use of integrative information technologies as a core enabler of supply chain integration and thus model it as antecedent to integration. The focus here is on *integrating* information technologies—technologies that facilitate the collection of vital information concerning key business processes and the sharing of such information across functional areas *and* across firm boundaries. We define supply chain integration to include *both upstream* or *supplier integration* and *downstream* or *customer integration*, building upon the recent work of Frohlich and Westbrook (2001). However, our definition of supply chain integration also encompasses *horizontal integration within* the firm since the various internal functions comprising a company are as much a part of the supply chain as are the company's suppliers and customers. We test whether the effect of supply chain integration on firm performance is *direct*, *indirect through an intermediate performance outcome*, or *both*. We chose customer service to mediate the relationship between integration and firm performance because it is widely touted as an immediate outcome of supply chain integration (see e.g., Stevens, 1989).

This study focuses on the automotive supply industry—the sampling frame is the top 150 independently owned first tier suppliers to General Motors, Ford, and Chrysler. This highly competitive industry segment encompasses a wide variety of products such as stamped metal, seating systems, and steering assemblies and is known for its emphasis on supply chain integration. The auto industry is also known for its implementation of integrative information technologies such as computerized production systems, company-wide information systems, and electronic data interchange (EDI) (see e.g., Rassameethes et al., 2000).

The paper is organized as follows. First, relevant literature is reviewed to identify and define the key constructs of the research model: integrative information technologies, supply chain integration, customer service, and financial performance. Second, the research model and its key propositions are developed from the literature. The study's methodology is then discussed, including measurement issues. Finally, the results are presented and their managerial implications are explored.

2. Key dimensions of an integrative supply chain strategy

Our attempt to identify the attributes of an integrative supply chain strategy led us to focus on technologies and practices that facilitate integration

within and across company boundaries. Such entities naturally fell into two categories: (1) technologies that facilitate the free flow of information both *within* and *between* companies; and (2) practices specifically aimed at achieving integration *between* functional areas *within* the firm and *with* suppliers and customers *outside* the firm. The result was a two-dimensional conceptualization of an integrated supply chain strategy. The first dimension, integrative information technologies, captures technologies that enable the achievement of integration both *internally* and *externally*. The second dimension, supply chain integration, captures the practices that minimally define *intra-firm* and *inter-firm boundary-spanning* in an automotive industry supply chain context.

2.1. Integrative information technologies

Integrative information technologies (or integrative IT) increase the flow of relevant information amongst process participants to facilitate the integration of processes that transcend functional and, in some cases, firm boundaries. For first tier suppliers in the automotive industry, key information technologies are: (1) computerized production systems; (2) integrated information systems; and (3) integrated electronic data interchange. Sheombar (1992), Walton and Marucheck (1998), Narasimhan and Carter (1998), Bowersox and Daugherty (1995), Lewis and Talalayevsky (1997), and Van Hoek et al. (1998) support the inclusion of these technologies in defining a macro-level IT construct.

Computerized production systems serve to integrate manufacturing activities into an overall planning system that typically stretches beyond the boundaries of the manufacturing unit. Key examples of such systems are MRP and MRPII (see e.g., Hammel and Kopczak, 1993). These systems are used for planning, tracking, and ordering components and products throughout the manufacturing operation and can be used to strengthen linkages with outside suppliers (e.g., the vendor scheduling capability of MRP as described in Vollmann et al., 1997). Integrated information systems enable all functional areas within the firm to access and transmit information from one area to another engendering *horizontal* or *cross-functional integration* within an organization. Electronic data interchange systems integrate electronic documents into business systems with no manual intervention, providing a system for sharing data among related firms. EDI allows for seamless communication between a company and its suppliers and customers, and thus greatly facilitates the ease, accuracy, and speed of routine interactions (see e.g., Mukhopadhyay et al., 1995). By enabling supply chain members to communicate effectively and efficiently, integrated EDI facilitates *vertical integration*, both upstream and downstream.

2.2. Supply chain integration

In developing a comprehensive conceptualization of supply chain integration, we included practices that strengthen linkages between companies occupying different positions in the supply chain (i.e., *vertical linkages*) and practices that foster *horizonta*l linkages amongst the various functional areas within the firm. There are two major categories of vertical linkages for first tier suppliers in the automotive industry. The first is between first tier suppliers and *their suppliers*, who are second tier automotive suppliers in the overall supply chain hierarchy. The second is between first tier suppliers and *their customers*, who are the automotive original equipment manufacturers (OEMs). Two major practices that accomplish integration across these linkages are *supplier partnering* and *closer customer relationships*, respectively.

Supplier partnering treats the supplier as a strategic collaborator. A partnership between a buying and supplying firm is a mutual ongoing relationship that involves a high level of trust, commitment over time, long-term contracts, joint conflict resolution, and the sharing of information, risks, and rewards (Ellram, 1990; Heide and John, 1990). Such collaboration affords many of the advantages of vertical ownership without the attendant loss of strategic flexibility (Spekman, 1988). Partners work together to ensure high product quality and low costs, with both companies sharing in the benefits. The partnership relationship might entail early supplier involvement in product design or acquiring access to superior supplier technological capabilities (Narasimhan and Das, 1999). Supplier partnering may enable firms to achieve a competitive stature that might otherwise have been unlikely.

Closer customer relationships can be viewed as a downstream counterpart to supplier partnering

initiatives. Closer customer relationships depend on a firm's strategic ability to determine its customers' requirements and the extent of its commitment to meet those requirements (Powell, 1995). Close customer relationships enable firms to proactively seek information on customer preferences and needs, and then become more responsive. Insights gained as a result of establishing strong relationships with customers can also be used to enhance operational effectiveness and cost efficiency. When firms achieve this level of intimacy with their customers, it becomes increasingly difficult for competitors to intervene (Stank et al., 2001).

With respect to the fostering of *horizontal* or *intra-firm* linkages, the most frequently cited practice in the literature is the use of cross-functional teams (Bishop, 1999; Guzzo and Dickson, 1996; Cohen and Bailey, 1997; Henke et al., 1993; Parker, 1994). The objective of cross-functional teams is collaboration—the forging of linkages among people and departments (who may have competing interests) to reach win-win outcomes (Jassawalla and Sashittal, 1999). Cross-functional teams decentralize decision making through lateral decision processes to speed up the decision process and to increase cooperation and "buy-in" from all parties (Bishop, 1999). Cross-functional teams are typically employed to achieve the integration needed across internal functions to ensure that quality or innovation objectives are realized (see e.g., Jassawalla and Sashittal, 1999; Hitt et al., 1999; Clark and Wheelwright, 1992). At times team members may include representatives of supplier and/or customer firms, so cross-functional teams can foster vertical linkages as well as horizontal ones.

A recent study of the effects of marketing/logistics collaborative integration on logistics performance relative to competitors highlights the importance of cross-functional teams for internal integration (Stank et al., 1999). In their multiple regression model, only one individual integration element, working together as a team, explained a significant amount of variance in terms of relative performance.

In summary, our supply chain integration construct encompasses both intra-firm as well as inter-firm integration, since the internal functions comprising a company are as much a part of the supply chain as are the external members. The items used to define the construct are perfectly "balanced" across the supply chain: one captures upstream (supplier) integration, one captures internal (cross-functional) integration, and one captures downstream (customer) integration.

3. Performance outcomes

The objective of an integrated supply chain strategy is to synchronize the requirements of the final customer with the flow of materials and information along the supply chain in order to reach a balance between high customer service and cost. Customer service is the yield of the entire system: it results from the combined efforts of all functions or segments of the supply chain, both internal and external to the firm (Stevens, 1989). In this research, *customer service* is treated as an intermediate performance outcome and *financial performance* (which inherently captures cost performance) is viewed as the final performance outcome.

Customer service can be viewed as a conglomeration of individual service dimensions whose importance may differ from one industry to the next. We included dimensions of service performance in our customer service construct that are general, as well as dimensions that are germane to a manufacturing context and specifically relevant to the automotive supply industry. The "order-winning" customer service items in our study were *pre-sale customer service*, *product support* (or post-sale customer service), *responsiveness to customers*, *delivery dependability*, and *delivery speed*. Note that in Stank et al.'s (1999) study of US manufacturers, half of the items in their set of service-oriented performance measures were also delivery-related. As part of our survey, we asked the respondents to rate the strategic importance of these items on a 1–7 scale where 1 = least important and 7 = extremely important. The mean importance ratings ranged from a low of 5.10 to a high of 6.35, providing strong empirical support for the competitive significance of these items in the automotive supply industry.

Financial performance was captured using a set of traditional performance measures: these included pre-tax return on assets (ROA), return on investment (ROI) and return on sales (ROS). Note that cost is a key constituent of each of these items.

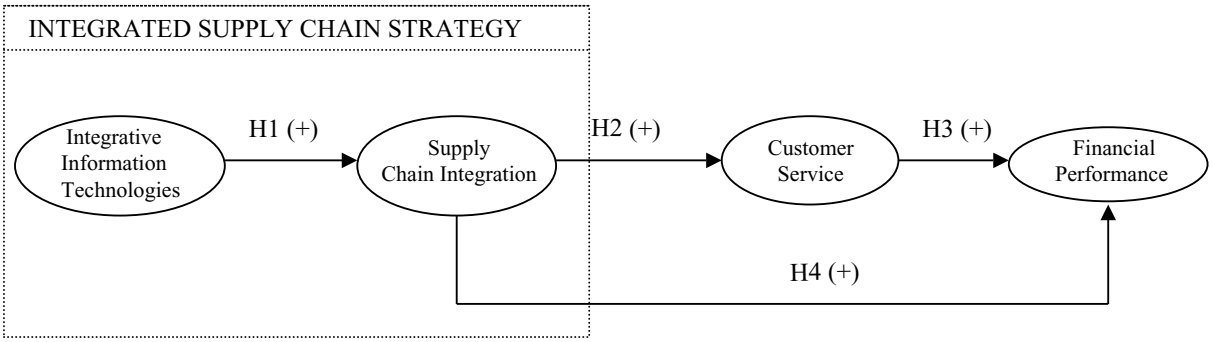

Fig. 1. A model of supply chain integration and performance.

4. The research model: supply chain integration and performance

The research model is shown in Fig. 1. Integrated information technologies and supply chain integration (the core constituents of an *integrative supply chain strategy*) are modeled as antecedents of customer service and financial performance. Of key interest in this research is whether the relationship between supply chain integration and financial performance is direct, indirect (i.e., completely mediated by customer service), or both direct *and* indirect (i.e., partially mediated by customer service). The research hypotheses are examined next.

4.1. The relationship of integrated information technologies to supply chain integration

An argument in support of a relationship between integrated information technologies and supply chain integration can be based on transaction cost economics. The literature in this area suggests that cooperation and coordination among firms is limited by the *transactions costs* of managing the interaction. Transactions costs consist of two components: (1) coordination costs, or the direct costs of integrating decisions between economic activities, and (2) transaction risk, or the cost associated with the risk of being exploited in the relationship (Stroeken, 2000). Researchers have demonstrated that IT can decrease *both* coordination costs (see e.g., Nooteboom, 1992) and transaction risk (Clemons and Row, 1992; Clemons et al., 1993). Thus, it should engender the cooperation and coordination necessary for achieving supply chain integration.

Burgess (1998) also supports an IT-integration link: he points out that information technologies can improve customer service and lower costs by providing *integration* between members of the supply chain. His article further identifies IT as the driving force for competitive logistics strategy. Holland et al. (1992) contend that EDI links (in particular) remove the constraints on volume and speed of the information flows between separate organizations and therefore enable them to gain the benefits of vertical integration but without ownership (see also Konsynski and McFarlan, 1990; Johnston and Lawrence, 1988). Sheombar (1992) offered a convincing argument to demonstrate that value-adding partnerships are enabled by EDI by his theoretical analysis of coordination in a two-organization partnership.

Ragatz et al. (1997) identified the use of common and linked information systems (such as EDI) as a key success factor for integrating suppliers into the new product/process/service development process. In a more recent study, Stroeken (2000) used six industry sectors (including automobile production) to examine the link between information technologies (IT) and supply chain innovation. He argued that IT is essential for achieving the process-oriented restructuring of the supply chain required for integration. The study results indicated that the introduction of IT *leads to* process innovation, or more broadly, supply chain integration, followed by cheaper, more diverse, and customer-specific products. Additional support for a linkage between integrative IT and supply chain integration is provided by Tallon et al.'s (1997) multi-dimensional assessment of IT's value. Their analysis indicated that any positive impact of IT *arises*

from its ability to coordinate value added activities. Such coordination is a key aspect of supply chain integration. Thus, both the conceptual and empirical literatures provide strong support for our first hypothesis:

H1. There is a positive relationship between integrated information technologies and supply chain integration.

4.2. The relationship of supply chain integration to customer service

Many researchers suggest that supply chain integration should affect customer service performance (see e.g., Stevens, 1989), but provide no empirical support. Nevertheless, several studies provide support for a either a direct or indirect relationship between upstream integration, horizontal (cross-functional) integration, or downstream integration, and various aspects of customer service performance.

Stank et al. (1999) provide empirical support for an internal integration-customer service link. While their study found no differences between firms that had high levels of marketing/logistics integration versus firms that had low levels of marketing/logistics integration with respect to basic services (such as on-time delivery), significant differences were reported for firms with higher levels of integration on service elements that transcend the basics (i.e., meeting key customers' needs, accommodating special service requests, and accommodating new product introductions).

Another study examined the *indirect* relationship between upstream or supplier integration and a specific aspect of customer service. Strategic outsourcing and supplier capability management (items similar to the supplier partnering component of our supply chain integration construct) were found to positively influence manufacturing goal achievement; which in turn was shown to affect *customer responsiveness* (Narasimhan and Jayaram, 1998). More recently, Stanley and Wisner (2001) identified a positive, sequential relationship involving upstream integration and service quality. Their results indicated that implementation of cooperative purchasing/supplier relationships enhanced the service quality to *internal* customers, which in turn affected the ability to deliver service quality to *external* customers.

Frohlich and Westbrook (2001) investigated the simultaneous effects of various supplier *and* customer integration strategies (or arcs of integration) on a wide variety of intermediate and final performance outcomes. These strategies encompassed a key information technologies (joint EDI access/networks) and other integrative practices (e.g., shared production plans). Their results indicated that companies with the greatest arcs of supplier *and* customer integration have the largest rates of performance improvement with respect to several intermediate performance outcomes including customer service, on-time delivery, delivery lead time, productivity, quality, and cost, as well as two measures of overall firm performance (market share and profitability). Note that our customer service construct encompasses several of the same intermediate performance outcomes. Their study provides the strongest support in the literature for a direct association between supply chain integration (which they defined to encompass *both* upstream and downstream integration) and customer service. Thus,

H2. There is a positive relationship between supply chain integration and customer service.

4.3. The relationship of customer service to financial performance

Customer service is an important competitive priority in the automobile industry, particularly delivery speed and product support (post-sale customer service). First tier suppliers that can quickly move product to OEM assembly lines and provide effective solutions when problems arise will engender sales volumes that should translate directly into profits.

With respect to the relationship between customer service and financial performance, there is a growing stream of research that has attempted to link service quality, a "service system" construct similar in nature to customer service, with financial performance. Superior service quality should help to generate greater revenue and yield greater profitability (see e.g., Rust et al., 1995). Although several studies have positively linked service quality with customer satisfaction (Crosby et al., 1990; Innis and La Londe, 1994, Leuthesser and Kohli, 1995) and satisfaction with financial performance (Fornell, 1992; Anderson et al., 1994; Fornell et al., 1996; Ittner and Larcker, 1996),

few studies have demonstrated that customer service *directly* affects financial performance. One notable exception is Chang and Chen (1998) who found a relationship between service quality and a subjective measure of profitability.

Customer service typically encompasses delivery performance in a manufacturing environment. In an empirical study of furniture manufacturers, Vickery et al. (1997) showed that delivery performance was related to several different measures of business performance (i.e., ROI, ROI growth, ROS growth, and sales growth). This study, in addition to Chang and Chen (1998), provides empirical support for our third hypothesis:

H3. There is a direct positive relationship between customer service and financial performance.

If only H1, H2, and H3 are supported, the resulting model would resemble a chain of sequentially related constructs comprising integrated information technologies, supply chain integration, customer service, and firm performance. Taken in order, each would be positively and directly related only to the immediately subsequent construct; all other relationships would be indirect. However, it is possible that another direct path exists (as detailed below): i.e., a direct path could exist from supply chain integration to firm financial performance.

4.4. Is financial performance determined directly by supply chain integration?

Frolich and Westbrook (2001) found a strong relationship from the largest arcs of supplier *and* customer integration to market share and profitability, but this was not the case for ROI, a key measure of financial performance. There is also mixed support in the literature for a *direct* relationship between certain items that are similar or identical to items comprising our integration construct and business performance. For example, Powell (1995) found that closeness to suppliers (an item similar to supplier partnering in our integration construct), but not closeness to customers (an item identical to closer customer relationships in our integration construct) was positively related to business performance. In contrast, Tan et al. (1998) found that taking advantage of supplier capabilities *and* emphasizing a long-term supply chain perspective in customer relationships were *both* highly correlated with firm performance. In addition, Carr and Pearson (1999) showed that cooperative buyer–supplier relationships positively impact financial performance. Finally, Johnson (1999) demonstrated that strategic (upstream) integration resulted in enhanced firm performance (in terms of sales, market share, and growth).

In the studies cited above, support exists for a direct link from supply chain integration and/or certain upstream or downstream elements of an integrated supply chain strategy to firm performance. However, most of these studies employed simple correlation-type analyses, and of those that tested more holistic models of integration and overall firm performance using structural equations modeling (SEM) (e.g., Johnson, 1999), none incorporated an analysis of both direct and indirect effects. Thus, the issue of whether the relationship is a direct one versus indirect (or both direct and indirect) has not been considered.

From a theoretical standpoint, the structures and practices comprising our supply chain integration construct are "visible" to customers, directly affect them, and/or significantly shape the service a firm provides to its customers. Thus, we contend that supply chain integration affects financial performance *through* customer service, with no direct effect of supply chain integration on financial performance (i.e., supply chain integration only *indirectly* affects financial performance). We believe that the literature lacks a holistic theoretical framework that explicitly incorporates direct and indirect effects: direct versus indirect effects were neither proposed nor tested. Thus, we will address this important issue of direct versus indirect effects straightforwardly by also hypothesizing and then testing for a *direct* positive link between supply chain integration and financial performance:

H4. There is a direct positive relationship between supply chain integration and financial performance.

By testing H4 above (in conjunction with H2 and H3), we will be able to determine whether the effects of an integrated supply chain strategy on financial performance are indeed indirect (as we argue), or direct as some empirical studies seem to indicate. Support for our position would mean that H4 is rejected (i.e., the path is not statistically different from zero), while

H2 and H3 are supported. Weak support for our position would result if H2 through H4 were all positive, since this would mean that there are both direct and indirect effects. Our arguments concerning direct versus indirect effects would be contradicted if either H2 or H3 were rejected.

5. Methods

5.1. Sample

The sampling frame for the study was identified with the assistance of a panel of experts from the Automotive Industry Action Group (AIAG), a professional association with over 1000 members. These industry experts recommended that we sample the top 150 (in terms of annual sales) independently owned first tier suppliers to General Motors, Ford, and Chrysler. These suppliers account for over 90% of the purchasing sales volume by North American automobile manufacturers. The unit of analysis is the Strategic Business Unit (SBU).

Greater attention to informant selection can help to overcome the common method variance problem when practical considerations require single respondents (Miller and Roth, 1994), and Phillips (1981) indicates that high (versus low) ranking informants tend to be more reliable sources of information. We chose to sample CEOs since they have the required knowledge of firm level performance.

CEOs were mailed questionnaires accompanied by explanatory letters. Repeated follow-up telephone calls were used to obtain definitive responses. We requested that the questionnaire be completed by the CEO (or Director) of an SBU which is a first tier supplier to an Original Equipment Manufacturer (OEM) in the North American automotive industry. CEOs of companies with multiple automotive business units were requested to select one, and to forward the questionnaire to the CEO of that unit.

The final sample consisted of 57 firms (for a response rate of about 38%). Mean sales were US$ 501,516,415 (S.D. = 637,456,698) and the mean number of employees was 2810 (S.D. = 3431). The mean percentage of SBU sales which were direct sales to North American OEMs was 83.67%. Table 1 provides frequency distributions of sales and number of employees.

Table 1
Frequency distribution of sales and number of employees

Annual sales (US$ million)	Number of firms	Percentage
(A) Frequency distribution of annual sales		
1–249.99	23	40.3
250–499.99	11	19.3
500–999.99	12	21.0
1000–1499.99	4	7.0
1500 and above	3	5.4
Missing data	4	7.0
Number of employees	**Number of firms**	**Percentage**
(B) Frequency distribution of number of employees		
1–1000	17	29.8
1001–2000	15	26.3
2001–3000	8	14
3001–4000	3	5.3
4001–5000	5	8.8
Above 5000	7	12.3
Missing data	2	3.5

The questionnaires were not distributed anonymously; all of the non-respondents were identified and all of them were willing to answer a few questions on the telephone. The most often cited reason for non-response was lack of time, followed by company policy. Early versus late respondents were compared (Armstrong and Overton, 1977) and no statistically significant differences were found on any study variables ($\alpha = 0.05$).

5.2. Validation of the research questionnaire

Our panel of experts assisted in the development and pre-testing of the questionnaire. The only substantive changes made were to ensure that the definitions of items were meaningful and comprehensive for the sample. This ensured content validity.

5.3. Measurement scale items

Respondents were asked to indicate the extent to which each of the individual items comprising the *integrated information technologies* and *supply chain integration* constructs was being used. There were three items for each of these constructs (see Table 3 for the list of items and the Appendix for a complete description). The respondent had the option of circling

Table 2
Correlation matrix and summary statistics

	Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Integrated electronic data interchange	4.800	1.394	–												
2	Integrated information systems	4.690	1.398	0.360**	–											
3	Computerized production systems	5.460	1.211	0.279*	0.423**	–										
4	Supplier partnering	4.820	1.252	0.148	0.448**	0.210	–									
5	Closer customer relationships	5.580	0.905	0.469**	0.245	0.325*	0.330*	–								
6	Cross-functional teams	5.430	1.100	0.237	0.383**	0.185	0.331*	0.418**	–							
7	Pre-sale customer service	5.470	1.020	0.149	−0.101	0.111	−0.005	0.162	0.078	–						
8	Product support	5.610	1.082	0.062	0.083	0.232	0.155	0.360**	0.330*	0.379**	–					
9	Responsiveness to customers	5.390	1.031	0.262	0.317*	0.314*	0.136	0.330*	0.253	0.537**	0.552**	–				
10	Delivery speed	5.140	1.231	0.125	0.268*	0.232	0.274*	0.342**	0.146	0.288*	0.484**	0.562**	–			
11	Delivery dependability	5.810	1.043	0.362**	0.378**	0.212	0.171	0.329*	0.268*	0.256	0.455**	0.536**	0.564**	–		
12	Pre-tax return on assets	4.900	1.376	−0.214	0.049	0.143	0.197	0.058	0.165	0.210	0.381**	0.204	0.210	0.113	–	
13	Return on investments	5.080	1.309	−0.180	0.122	0.179	0.107	0.060	0.196	0.235	0.375**	0.234	0.113	0.096	0.843**	–
14	Return on sales	4.920	1.342	−0.050	0.116	0.302*	0.109	0.049	0.035	0.206	0.329*	0.251	0.086	0.152	0.824**	0.828**

* $P < 0.05$.
** $P < 0.01$.

Table 3
Results of confirmatory factor analysis

Construct	Cronbach's alpha	Items	CFA standard loadings*	*t*-values
Integrative information technologies	0.627	Integrated electronic data interchange	0.549	3.736
		Integrated information systems	0.702	4.831
		Computerized production systems	0.566	3.860
Supply chain integration	0.614	Supplier partnering	0.468	3.226
		Closer customer relationships	0.700	4.981
		Cross-functional teams	0.571	4.023
Customer service	0.810	Pre-sale customer service	0.517	3.837
		Product support	0.718	5.760
		Responsiveness to customers	0.830	7.038
		Delivery speed	0.699	5.561
		Delivery dependability	0.666	5.222
Financial performance	0.939	Pre-tax return on assets	0.906	8.493
		Return on investment	0.904	8.457
		Return on sales	0.871	7.982

Fit indices: $\chi^2 = 91.32$; d.f. = 71; $P = 0.06$; Bentler Bonnet non-normed fit index (BBNNFI) = 0.91; comparative fit index (CFI) = 0.93; goodness fit index (GFI) = 0.82; root mean square residual (RMSR) = 0.09.

*$P \leq 0.01$.

"not used". Otherwise, the "extent of use" scales were 7-point scales with the endpoints "extremely low use of initiative" (=1) and "extremely high use of initiative" (=7).

Customer service performance was rated relative to major competitors with respect to five items: product support (i.e., post-sale customer service), pre-sale customer service, responsiveness to customers, delivery speed and delivery dependability/reliability. Scales with endpoints "poor" (=1) and "excellent" (=7) were used.

Financial performance was captured by three items: (1) pre-tax ROA; (2) ROI; and (3) ROS. For each item, respondents were asked to provide a *subjective* assessment of SBU performance *relative to major industry competitors* on a seven point scale with endpoints "worst in industry" (=1) and "best in industry" (=7).

In addition, *actual values* for financial performance were obtained from those willing to release such objective information. In many empirical studies, subjective ratings are used to measure firm performance since respondents are often unwilling to release sensitive "hard" data (see e.g., Porter, 1979; Vickery et al., 1993; Ward et al., 1994). About half of our sample provided both subjective ratings and actual values. All correlations of subjective ratings versus the respective actual values were significant at 0.05 (one-tail test; null hypothesis $\rho \geq 0$), except for ROI at 0.10. The subjective ratings are thus sufficiently valid indicators of firm performance to warrant their use. Past research has also found that managerial assessments are consistent with objective internal performance (Dess and Robinson, 1984; Vickery et al., 1994) and even with external secondary data (Venkatraman and Ramanujam, 1986). Therefore, all subsequent analyses use the subjective ratings of financial performance.

Descriptive statistics (means and standard deviations) as well as the correlation matrix of all variables are presented in Table 2. The Cronbach's alpha for the constructs are given in Table 3. All were adequate, with one over 0.90, one over 0.80 and the lowest two over 0.60 (Nunnally, 1978).

6. Results

All SEM analyses were conducted using EQS (Bentler, 1997) with the covariance matrix as input and maximum likelihood methods.

6.1. Measurement model

Prior to estimating the structural model in Fig. 1, a confirmatory factor analysis (CFA) was conducted

to verify the measurement model (Anderson and Gerbing, 1988). The results are reported in Table 3. The overall fit of the measurement model was good ($\chi^2 = 91.32$; d.f. = 71; $P = 0.06$; Bentler Bonnet non-normed fit index (BBNNFI) = 0.91; comparative fit index (CFI) = 0.93; goodness fit index (GFI) = 0.82; root mean square residual (RMSR) = 0.09). All specified factor loadings were highly significant, which indicates good convergent validity among the measures of each construct. The Lagrange Multiplier (LM) test for omitted paths revealed no significant cross-loadings among the items, indicating discriminant validity. Good convergent and discriminant validities are indicators of construct validity.

6.2. Structural model: analysis of the hypothesized paths

First, we evaluated overall model fit. The structural model (i.e., measurement and path model combined) fit well as indicated by the following model fit statistics: $\chi^2 = 91.72$, d.f. = 73, $P = 0.07$; BBNNFI = 0.92; CFI = 0.94; GFI = 0.85; and RMSR = 0.09. Because the sample size was relatively small, we verified that these model results were valid through simulation analyses (50 replications bootstrapped from the original sample). With $\chi^2 = 88.18$, $P = 0.11$ and CFI = 0.95 for this model, the simulation results confirmed the ordinary maximum likelihood (ML) model results.

Next, we evaluated the individual paths of the model. These results are summarized in Table 4. H1 proposed a positive relationship between integrative information technologies and supply chain integration. This hypothesis was supported since the standardized estimate was 0.824 ($t = 2.395$, $P < 0.01$). H2 stated that there was a positive relationship between supply chain integration and customer service. This hypothesis was supported since the standardized estimate was 0.637 ($t = 2.624$ $P < 0.01$). Note that we did not hypothesize a direct relationship from integrative information technologies to customer service, and LM tests show that such a relationship would not be significant. Thus, the relationship of integrative information technologies to customer service is indirect, through supply chain integration.

The relationship of customer service to financial performance (H3) was also supported (standardized estimate = 0.596, $t = 2.585$, $P < 0.01$). In addition, we discussed the direct relationships to financial performance of supply chain integration (H4). Recall that we included this hypothesis because the literature offers some support for it, but we had argued that once customer service was included in the model, this direct relationship would prove to be non-significant. Our results show that indeed the direct relationship of supply chain integration to performance is non-significant: i.e., customer service fully (as opposed to partially) mediates the relationship of supply chain integration to performance (−0.31, n.s.).

Finally, we evaluated a model in which the path from supply chain integration direct to financial performance (representing H4) was set to zero. The results were substantively the same. The standardized path coefficients representing H1, H2 and H3 changed very little in magnitude: they were 0.766 ($t = 2.279$) for integrative information technologies to supply chain integration, 0.665 ($t = 2.659$) for supply chain integration to customer service, and 0.382 ($t = 2.561$) for customer service to performance. LM tests show that the addition of other paths would not significantly improve the model. For this model, we also

Table 4
Path model results

Paths	Standardized path coefficient	*t*-values
H1: integrative information technologies → supply chain integration	0.824	2.395*
H2: supply chain integration → customer service	0.637	2.624*
H3: customer service → financial performance	0.596	2.585*
H4: supply chain integration → financial performance	−0.304	n.s.

Fit indices: $\chi^2 = 91.72$; d.f. = 73; $P = 0.07$; Bentler Bonnet non-normed fit index (BBNNFI) = 0.92; comparative fit index (CFI) = 0.94; goodness fit index (GFI) = 0.85; root mean square residual (RMSR) = 0.09.

*$P \leq 0.01$.

calculated the total effects. They were: (1) integrative information technologies (through supply chain integration) to customer service, 0.511 ($t = 1.573$); and (2) integrative information technologies (through supply chain integration and customer service) to performance, 0.057 ($t = 0.356$).

7. Discussion

This research proposed and tested a model of direct and indirect relationships involving four constructs: integrative information technologies, supply chain integration, customer service performance, and financial performance. Overall, we found that these four constructs were related to each other in the sequential order specified by the research model. Below we discuss first measurement and then the main results.

7.1. Measurement model

We began by specifying and later testing the measurement model. Overall, we were successful in specifying two *macro-level* constructs relevant to an integrated supply chain strategy: integrated information technologies and supply chain integration. Specification of such macro-level constructs is a prerequisite for research on supply chain integration to advance: if the antecedents or the effects of integration constructs are to be hypothesized and tested, then macro-level (i.e., aggregated) constructs must be measured.

The first construct, *integrated information technologies*, was measured using integrated EDI, integrated information systems, and computerized production systems (e.g., MRPII). The results showed that these items were correlated at $P = 0.05$ or better, that Cronbach's alpha was acceptable at 0.63, and that they fit together well in a CFA with no item cross-loadings. The inclusion of integrated EDI and information systems is probably generalizable to a wide variety of industries, while the inclusion of computerized production systems may be more specific to the automotive supply industry.

Second, *supply chain integration* was measured using supplier partnering, cross-functional teams, and closer customer relationships. With this construct, we attempted to tap upstream, internal, and downstream integrative boundary-spanning practices. These items were correlated at $P < 0.05$, and Cronbach's alpha was an acceptable 0.61. Furthermore, CFA showed that the fit of these measures to their construct was quite adequate, with no significant cross-loadings. Previous literature has focused on the *individual effects* on firm performance of downstream integration (Tan et al., 1998), internal integration (e.g., Stank et al., 1999), and/or upstream integration (e.g., Stanley and Wisner, 2001; Tan et al., 1998), with an unbalanced research emphasis on the upstream/supplier aspects (Eloranta and Hameri, 1991). One study Frohlich and Westbrook, 2001 considered the simultaneous effects of two of the three—upstream and downstream integration—in their aptly labeled "arcs of integration" study. But past research has failed to examine the *simultaneous* effect of a construct encompassing all three. We do not claim that our construct is useful for diagnostic purposes however: if a firm wishes to identify specific areas where integration is lacking, managers would have to develop an extensive list for each of the upstream, internal, and downstream domains. Many of the items on such lists would be industry or even company specific.

Third, *customer service performance* was measured by performance in the areas of pre-sale customer service, product support (post-sale customer service), responsiveness to customers, delivery dependability, and delivery speed. All were highly correlated, and Cronbach's alpha was 0.81. CFA supported the construct's validity: no measures cross-loaded and the lowest standardized loading was 0.517. This was a macro-level customer service performance construct, including both pre- and post-sale customer service, responsiveness, and delivery. For most manufacturers, these measurement items probably encompass the essence of customer service performance.

Fourth, *firm performance* was measured by managers' subjective evaluations of pre-tax ROA, ROI, and ROS relative to major industry competitors. We first verified that the chosen subjective scales had external validity by correlating each with the corresponding actual value (obtained from about one third of the sample). The scales were also highly correlated with one another (>0.80) and their Cronbach's alpha was 0.931. CFA showed high standardized loadings (the lowest was 0.871) and no cross-loadings,

confirming construct validity. Our measures focus on financial performance rather than on growth (e.g., growth in ROI or in ROS) or on market performance measures (such as market share) or on stock prices. Depending on the strategic goals of the firm, other overall firm performance measures may be appropriate.

7.2. Structural path model: direct versus indirect paths

The results showed the following positive *direct* relationships: (1) from integrated information technologies to supply chain integration; (2) from supply chain integration to customer service performance; and (3) from customer service performance to financial performance. All other direct paths examined were non-significant. Overall, the "big picture" that emerges from our research can be described as follows: first, integrated information technologies impacts the coordination/integration of value-added activities (in our case, supply chain integration; see e.g., Tallon et al., 1997); second, the latter construct impacts some aspect of competitive performance (in our case, customer service performance); and third, that aspect of competitive performance affects overall firm performance (in our case, financial performance).

The results showed a positive direct relationship *only* from customer service to firm performance. There were no significant direct paths to firm performance from supply chain integration, nor from integrated information technologies. In other words, customer service fully (as opposed to partially) mediated the relationships of both integrated information technologies and supply chain integration to firm performance (i.e., these relationships were *indirect* through customer service). These results demonstrate that it is possible for a construct to be very important in the chain of events and yet have little or no detectable direct impact on overall firm financial performance.

Since the direct path from supply chain integration to financial performance was non-significant, the relationship of supply chain integration to financial performance was *indirect*, through customer service. Full mediation by customer service means that neither reorganizing internally with the goal of internal integration, nor implementing practices with the goal of external integration (with suppliers or customers) will necessarily translate directly into enhanced firm financial performance. Rather, any management actions must first have an impact on key customer service dimensions, and it is this enhanced customer service that then engenders financial performance. Managers should not expect supply chain integration to directly impact firm financial performance.

There was also no direct relationship from integrated information technologies to firm performance. A review of the IT literature reveals mixed results with respect to an IT-performance linkage; however, overall there is no strong evidence for a direct relationship between IT and firm financial performance (cf. Brynjolfsson, 1993; Mukhopadhyay et al., 1995; Hitt and Brynjolfsson, 1996; Strassman, 1997, Hu and Plant, 2001; Rai et al., 1997; Mahmood et al., 1998). It is important to note that we found no evidence of a direct path from integrated information technologies to customer service performance either; rather, IT's impact on customer service is indirect and completely mediated by supply chain integration. The more a firm has invested in an integrated information technologies infrastructure, the more likely it is that the firm will achieve integration both internally across functional areas, and externally with suppliers and customers. In other words, it is supply chain integration that directly delivers enhanced customer service performance; however, this supply chain integration is facilitated by integrated information technologies. Managers should not expect integrated information technologies to directly impact either customer service performance or firm financial performance.

A key contribution of our research is addressing the issue of direct versus indirect effects on firm performance by first evaluating the sometimes contradictory literature, and then testing whether the effects were direct, or indirect (i.e., fully mediated), or both (i.e., partially mediated). Although the literature seems to suggest the possibilities of direct links to firm performance either from IT or from internal, upstream, or downstream integration (for example), ours is the first study to test explicitly these direct *versus* indirect effects. The explicit examination of direct versus indirect effects is important because in one industry or context, the links in the chain may be sufficiently strong that the total indirect effect is significant and thus researchers who omit intermediate constructs in the chain will

still detect an effect. In another industry or context, the same links individually may be significant, but the total indirect effect may be non-significant. The key point is that, even if the "true" models were substantively the same, researchers may reach completely different conclusions depending on which direct and indirect effects were tested. Similarly, managers who expect a direct effect or impact of some action and then cannot detect such an impact may conclude that the action taken was a failure when in fact it was not.

7.3. Limitations

The findings of this study are representative of supply chain integration by key systems suppliers to the North American automotive OEM industry. The auto supplier industry in itself is understandably much broader than the population base of this study. For example, our study does not address supply chain integration in firms representing component or sub assemblies or raw material suppliers to the North American automotive industry. Another limitation is that this study focused on supply chain integration strategies deployed by the top systems suppliers in North America. The extent of maturity and experience enjoyed in this context is not transferable to other contexts such as Europe or Asia. It is conceivable that different contextual and boundary conditions might play a role in the effectiveness of the same supply chain strategies in contexts involving significant operations in overseas locations other than North America.

Similar to most empirical studies that have been conducted in the past, this study also examines a 'snapshot image' of supply chain integration. Expertise in supply chain integration takes an inordinate amount of time and effort through countless experiments of trial and error before the true benefits of integration can be enjoyed. This study isolated significant effects enjoyed by the top 150 (in terms of annual sales) independently owned first tier suppliers to General Motors, Ford, and Chrysler. These suppliers are most likely to be on the cutting edge of supply chain integration and farthest along on the evolutionary path to seamless business processes. To this extent, capturing the different options of experimentation preceding successful supply chain integration is worthy of a specific dedicated study. Typically, such studies are conducted through in depth longitudinal case studies involving a few firms.

Appendix A. Definitions for the items comprising the research constructs

1. *Integrated electronic data interchange*: The integration of paper-less (electronic) documents into business systems with no manual intervention.
2. *Integrated information systems*: The use of information technologies that enables all functional areas to access and transmit information from one to another.
3. *Computerized production systems*: The use of computer systems (such as MRP or MRPII) for planning, tracking and ordering components and products throughout the manufacturing operations.
4. *Supplier partnering*: Bringing all of the participants in the product life cycle into the process early on so even suppliers and customers can provide input to each others' processes.
5. *Closer customer relationships*: Determining customers' (both inside and outside the firm) requirements, then meeting those requirements no matter what it takes.
6. *Cross-functional teams*: The use of cross-functional teams to support the strategic objectives of innovation and total quality management.
7. *Pre-sale customer service*: The ability to service the customer during the purchase decision process (i.e., before the customer buys the product).
8. *Product support*: The ability to service the customer in providing product support after the sale of the product to ensure continuing customer satisfaction.
9. *Responsiveness to customers*: The ability to minimize the time it takes to cater to customer needs by processing and solving customer complaints by rapid confirmation of orders and by minimizing customer information lead time.
10. *Delivery speed*: The ability to minimize the time between receipt of customer order and final delivery, to as close to zero as possible.
11. *Delivery dependability*: The ability to deliver on or before the promised scheduled due date consistently.

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