The Effects of Cross-Functional Integration on Profitability, Process Efficiency, and Asset Productivity

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We employ information processing theory (IPT) to posit beneficial impacts of internal integration on firm profitability and its underlying components of process efficiency and asset productivity. We further hypothesize that these effects are greater for firms that operate wider spans of supply chain processes. These expectations are tested with the combination of two different data sources: primary data collected to gauge levels of internal integration, and secondary data collected from financial reports including profitability performance and related financial ratios. The results provide evidence that internal integration mainly affects profits by driving process efficiencies. These efficiencies appear to be especially significant in sales, general, and administrative related costs for firms that have broad process spans. In contrast, the data analysis offers no evidence of a relationship between internal integration and asset productivity. Based on these findings, we point out important implications for the applicability of IPT in explaining the effects of internal integration, and identify a call for action for practitioners. Overall, our study enhances both the rigor and relevance of internal integration research by grounding it in IPT, by utilizing objectively reported financial data, by identifying specific cost benefits, and by studying the impact of process span as an important contingency.

Keywords: internal (cross-functional) integration; information processing theory; financial data; profitability; process efficiency; asset productivity; empirical study

INTRODUCTION

Internal integration, also known as cross-functional, inter-functional, and inter-departmental integration, is defined as the mutual alignment of cross-functional interdependencies through interaction, information sharing, and collaboration (Kahn and Mentzer 1998; Morash and Clinton 1998; Pagell 2004). Research into the effects of internal integration is still emerging, often only descriptive, and lacking deep theoretical grounding (a summary of past research is provided in Appendix A). More rigor and relevance is needed (Frankel and Mollenkopf 2013), particularly regarding internal integration's performance impacts. From the perspective of practice, many supply chain managers perceive that their companies have become proficient in external integration, but not in internal integration (Poirier et al. 2008). Organizational, political, and resource-related challenges make high levels of integration difficult to achieve and maintain, and current research falls short of providing the strong evidence needed to make a solid business case for investments in organizational changes, training, and technologies typically required. Demonstrated impacts on profit metrics, as studied in this research, are needed to convince managers of the benefits associated with internal integration (cf. Timme and Williams-Timme 2000; Manrodt et al. 2005; Ellinger et al. 2011).

This research article documents our efforts to extend work on internal integration. We study the impact of internal integration on profitability, through process efficiency and asset specificity. Specifically, we add rigor and relevance to the study of internal integration by deeply grounding our expectations in information processing theory (IPT), by measuring achieved (rather than expected) internal integration, by investigating the direct effects of internal integration on objectively reported measures of financial performance, and by studying supply chain process span as an important contingency that moderates integration's effects. This work thus significantly extends past research efforts which have often lacked a theoretical anchor, have exclusively relied upon perceptual measures of performance, and have largely ignored contingency factors other than external integration and uncertainty. From a managerial perspective, by demonstrating bottom-line benefits, we issue a call for practitioners to become more internally integrated, with a focus on the apparent transactional benefits that integration provides.

Our arguments relating internal integration to profitability, process efficiency and asset productivity are grounded in the IPT (Galbraith 1974). Specifically, we view internal integration as a key information processing capability that reduces both uncertainty and equivocality, thus enabling better process efficiency and asset productivity. Such capability is posited to be especially valuable in today's complex, dynamic, and hypercompetitive market environment. Internal integration helps workers across functions to process gathered information better and faster, to develop a shared understanding, and distribute it to the most appropriate constituents within the firm, thus providing an important infrastructural support for value-creating processes. In addition, by developing an integrative foundation for processing and sharing information, the bounded rationality (Williamson 1985) of workers is likely reduced, enabling better decision making.

Building upon the arguments above, we contribute to research and practice by developing a more precise theory of IPT and its applicability to internal integration. In addition, the results of the study suggest even finer-grained applications of the theory. While we confirm the positive association of internal integration with profitability return-on-assets [ROA] through better process efficiencies, the association of internal integration with greater

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asset productivity is not supported. These findings suggest that internal integration benefits apply more to transactional and transformational efficiencies reflected by labor and material costs, rather than to utilization or other productivity factors reflected by capital costs. We further find that the association of internal integration with profit is magnified by firms' process spans. The added benefits of integration for firms with wider process spans appear to be mainly a product of better transactional efficiencies reflected by lower sales, general, and administrative (SG&A) costs.

These findings contribute to the understanding of internal integration by adding specificity and a novel perspective on its effects. In addition, the findings provide guidance for managers regarding what they should expect, and how they should measure the impacts of internal integration efforts. We thus extend the empirical corroboration and confirmation of a concept considered to be fundamental to supply chain management (SCM).

The remainder of this paper proceeds as follows. First, we review key tenets of IPT and substantiate its application to our research. In addition, we review extant work on internal integration and demonstrate the need for more rigor and relevance in its study. Second, we develop a set of hypotheses relating internal integration to various financial performance measures, and provide arguments for the moderating role of process span. Our expectations are grounded in IPT. Third, we describe the methodology applied to test our hypotheses, including an overview of the data collection and sample, and the measures. Fourth, we report the statistical analyses and results, followed by exploratory extensions and robustness tests. Fifth, we discuss our results and highlight their implications, especially in terms of how we have enhanced the rigor and relevance of internal integration's study, and how our results extend the IPT. And sixth, we conclude our work with a summary, including limitations, and avenues for future research.

INFORMATION PROCESSING THEORY AND INTERNAL INTEGRATION

Information processing theory

IPT views organizations as entities that aim to efficiently gather, interpret, synthesize, and coordinate information (Burns and Wholey 1993). Underlying this notion is the assumption that firms are open social systems that face uncertainties (Tushman and Nadler 1978). This condition creates the need for information processing mechanisms. Galbraith (1974) suggests three ways to manage low levels of uncertainty: coordination by rules or programs, hierarchy, and coordination by targets and goals. However, if uncertainty levels exceed the processing capabilities of these routine mechanisms, Galbraith (1974) maintains that organizations can either reduce the need for information processing (via the creation of slack resources, buffers, and self-contained tasks) or increase the capacity to process information (via investment in vertical information systems and creation of lateral relations).

The IPT provides a useful lens to investigate the link between internal integration and financial performance (profitability, process efficiency and asset productivity) in three important ways.

First, today's competitive and dynamic environment is characterized by shortening product life cycles, increasing customer expectations, heightening competition, and decreasing margins (Weick and Quinn 1999). As such, dealing with uncertainty has become a primary concern for managers (Merschmann and Thonemann 2011). Information can be gathered from suppliers and customers as a means to reduce or manage uncertainties (Kahn et al. 2006). However, firms also need internal information processing capabilities in order to interpret and channel externally collected information to the most appropriate internal stakeholders (Schoenherr and Swink 2012). Moreover, divisional organizational structures can also create uncertainties within a firm. For example, when interdependent departments conduct planning and decision making independently, one unit is left with uncertainty about another department's actions. In contrast, integrative organizational structures (e.g., cross-functional teams, an example of lateral relations) clarify interdependencies and build information processing capabilities (Tushman and Nadler 1978). Such structures, along with other integrative lateral processes and vertical information systems, reduce uncertainties by giving organizations the ability to share and structure information for best use.

Second, adaptations of the IPT include the notion of *equivocality*, along with uncertainty, as a driver of information processing needs. Once managers acquire information, deciding on the best action might not be as straightforward as it would seem. The meaning of information can be unclear and subject to different interpretations (Daft and Macintosh 1981), representing what has been termed equivocality (Daft and Weick 1984). Information thus needs to be *processed*, that is, sense-making needs to take place, and a common understanding needs to be developed. Again, internal integration mechanisms are thought to enable such information processing, thereby helping to promote a shared interpretation of information among various decision makers (Daft and Lengel 1986).

Third, due to the boundary spanning nature of SCM decisions, decision makers need to consider various other functions and departments within the firm (Swink et al. 2007). However, because of potential limitations in experience, myopic perspectives, and the limited availability of information, departmental decision makers are often subject to bounded rationality (Galbraith 1973). This means that their access, interpretations, and applications of information are bounded by the limits imposed by organizational position, experience, and perspective. Internal integration serves to reduce and overcome bounded rationality, as it enables a wider range of personnel to participate in joint evaluations and planning for the use of knowledge content. In addition, internal integration promotes collaboration between functional areas within the firm, thereby leading to greater goal alignment, cross-fertilization, broadened experience, and ultimately, improved organizational performance (Schoenherr and Swink 2012).

By addressing these three organizational challenges collectively, the IPT serves as a useful frame for describing the impacts of information processing capability on organizational effectiveness. In the context of this research, we use arguments from the IPT to develop expectations regarding the association of internal integration with firm profitability, as explained by improvements in process efficiency and asset productivity.

The need for more rigor and relevance in the study of internal integration

Internal (cross-functional) integration enables better intra-firm alignment across functions through enhanced information sharing, collaboration, utilization of each department's strengths and competencies, and work toward common goals (Schoenherr and Swink 2012). Greater connectivity and coordination across firm functions can break down the "silo" mentality and local optimization, fostering a process view and enabling global optimization (Lawrence and Lorsch 1967). Through internal integration, functional specialists obtain a broader and more informed picture of firm processes and objectives (Keller 2001), and are more likely to understand and utilize firm resources located in different departments.

While these broad tenets are fairly well accepted, more rigor and relevance is needed in the study of internal integration, specifically as it relates to performance. Appendix A provides a summary of research studies that have specifically addressed the effects of internal integration on performance outcomes. These foundational studies make important contributions to knowledge in SCM (see the column "Findings" in Appendix A). However, a readily apparent shortcoming in the body of literature is the varying levels of focus and definition represented in operationalizations of internal integration. For example, Stank et al. (1999) and Ellinger et al. (2000) study only the integration of marketing and logistics, and Springinklee and Wallenburg (2012) consider only the integration of the logistics and the production functions, where other studies are broader in the scopes of inter-departmental integration that they address. Moreover, operationalizations of internal integration in some of these studies assess the presence or absence of *infrastructural enablers* of integration (e.g., presence of information systems) (Gattiker and Goodhue 2004) rather than assessing levels of *achieved* integration. Several researchers note the importance of measuring achieved, rather than intended, integration (Pagell 2004; Springinklee and Wallenburg 2012; Turkulainen and Ketokivi 2012).

Another limitation of prior works on internal integration is the frequent absence of a strong theoretical grounding for the researchers' expectations. Arguments relating internal integration to performance are, in many studies, limited to restatements of what internal integration is, for example, alignment, better communication and cooperation, richer information sharing, more intense interactions, etc. Few statements are provided that identify the means by which these attributes of integration are linked to specific performance elements. Exceptions include Wong et al. (2011) and Germain and Iyer (2006), who rely on process-oriented views to argue for internal integration's role in the elimination of resource redundancies and nonvalue-added activities. Others have highlighted the value of information access for improved decision making as an important benefit of internal integration (Stank et al. 1999; Germain and Iyer 2006). Schoenherr and Swink (2012) employ IPT as a means for explaining the information-driven benefits of internal integration. We extend these foregoing ideas, applying additional rigor to the theoretical development of arguments tying internal integration to performance (van Weele and van Raaij 2014).

All of the studies described in Appendix A address relationships of internal integration to some aspect of organizational performance. However, it should be noted that the primary focus of some studies is the indirect or moderating effect of internal integration on dimensions of operational performance (e.g., relative cost, quality, etc.), rather than its potential direct effect on firm profitability (Narasimhan and Kim 2002; Germain and Iyer 2006; Schoenherr and Swink 2012). Moreover, associations of internal integration to immediate operational outcomes tend to be more strongly represented in the literature than associations with financial performance. For instance, researchers have associated internal integration with greater logistics performance (Stank et al. 1999, 2001b; Ellinger et al. 2000; Sanders and Premus 2005; Germain and Iyer 2006), greater supply chain agility/responsiveness (Braunscheidel and Suresh 2009; Flynn et al. 2010), and better quality, delivery, flexibility and cost performance (Sanders and Premus 2005; Wong et al. 2011; Schoenherr and Swink 2012).

Of the few studies that assessed the impact of internal integration on financial performance, both significant and non-significant relationships are evident (e.g., Rodrigues et al. 2004). While Flynn et al. (2010) and Chen et al. (2007) find a positive association of internal integration with overall business performance (an amalgam of sales, profit, and growth indicators), associations of internal integration with financial measures are not significant in studies by Ellinger et al. (2000) and Germain and Iyer (2006). One reason for these inconsistent results may be the studies' use of self-reported, perceptual financial metrics measured on ordinal or interval scales, often amalgamated into single factor scores. Obtaining objective measures is difficult, and the use of perceptual measures has been shown to be valid in many empirical research settings. Nevertheless, perceptual measures of performance are subject to certain biases, and they provide little basis for concrete comparisons or projections of objectively measured impacts (Ketokivi and Schroeder 2004; Wall et al. 2004). The lack of evidence of direct financial benefits of internal integration leaves open the opportunity to provide a more compelling case for investments in internal integration.

A final indication of the nascent nature of research in this area is that few contingencies regarding the effects of internal integration have been identified. Several researchers have tested interactions of internal integration with forms of external integration (Germain and Iyer 2006; Flynn et al. 2010; Schoenherr and Swink 2012; Williams et al. 2013), and one study has examined environmental uncertainty (Wong et al. 2011). However, firm structural characteristics that may amplify or dampen the impacts of internal integration have not been examined. Such work is needed to establish boundary conditions on expectations and developing theories related to internal integration.

In sum, many research studies have addressed internal integration, offering foundational concepts and correlating managerial perceptions of integration and performance. To add relevance and rigor to the study of internal integration, we build upon these works to offer a more theoretically grounded set of arguments, and to address some of their limitations. Namely, we investigate the impacts of achieved integration on objectively measured aspects of financial performance (profitability, process efficiency,

and asset productivity), utilizing secondary data sources. In addition, we test the moderating effect of a firm's supply chain process span, in order to develop further insights into the nature and limits of integration's effects.

THEORY DEVELOPMENT AND HYPOTHESES

Rapid change has become the norm in today's business environment. As a result, companies face increasing levels of uncertainty (Weick and Quinn 1999; Merschmann and Thonemann 2011). The IPT suggests that high levels of uncertainty can be managed through buffers (e.g., slack capacity, inventory) or through enhanced information processing capabilities (e.g., internal integration) (Galbraith 1973). Accordingly, we maintain that internal integration serves as a replacement for asset-intensive buffers, and that it reduces process inefficiencies that arise from uncertainty, equivocality, and the bounded rationality of decision makers. Internal integration enables organizations to more effectively gather and process dispersed information, to make sense of it, and then to distribute it to the most appropriate internal constituents, thereby enabling decision makers to make more robust and optimal strategies. Galbraith (1974) specifically refers to the power of "integrating roles" in this regard. More integrated decision making regarding resource applications and process planning is expected to positively impact a firm's profitability, which is often operationalized as ROA.

More specifically, achieved internal integration improves interfaces between internal functions, leading to enhanced communication, coordination and collaboration (Pagell 2004). According to Galbraith (1973), internal integration is achieved through lateral relations and vertical information systems; examples include team-oriented structures, cross-functional planning processes, rotational job assignments, liaison roles, and integrated information systems (Stevens 1989; Gattiker and Goodhue 2004). In describing IPT, Galbraith (1973) maintains that such lateral relations and vertical information systems work together to enhance the information processing capacity of the organization. Given this capacity, information travels faster and more accurately through internally integrated processes, enabling greater agility and ensuing adaptation of strategy (Galbraith 1974). Additionally, reductions in equivocality and bounded rationality can enhance visibility and inter-departmental interactions aimed at rationalizing redundant resources and duplications of effort. Internal integration may further foster unique relationships between individuals in the firm, going beyond simple or mechanistic connections. In an ideal setting, a community is created to share, combine and integrate functional expertise (Rosenzweig et al. 2003).

These information processing and collaborative benefits of achieved internal integration, as expressed in the IPT, explain why we expect integration to be associated with greater firm profitability. Such integration is complex, difficult, and requires considerable time, effort, trust and conviction (Ellinger et al. 2006; Richey et al. 2010). The rare firms that are able to achieve high levels of internal integration are expected to enjoy significant profitability advantages by virtue of their superior information processing capacities.

H_1: *Internal integration is positively associated with firm profitability (ROA).*

The foregoing hypothesis posits a high level relationship between internal integration and firm profitability (ROA). To add further rigor to our investigation, we consider relationships between internal integration and two key components of profitability, process efficiency and asset productivity. These components of profitability are typically measured by return-on-sales (ROS) and asset turnover (ATO), respectively (Kinney and Wempe 2002).[1] We first focus on ROS, which is regarded as a gauge of a firm's efficiency (Income/Sales) (Kinney and Wempe 2002). For a given level of sales, ROS is improved by making processes more efficient in ways that serve to lower various cost elements, including costs of goods sold (COGS) and SG&A costs; these two cost categories often represent the majority of a firm's operating costs, and as such, they have been studied intensely (Lévesque et al. 2012).

Consistent with tenets of IPT, we expect that the information processing capabilities afforded by internal integration lead to greater process efficiencies. Specifically, a central trade-off in organizational design involves the benefits of specialization and local responsiveness in divisionalized forms, versus the benefits of control, standardization, and efficiency in centralized forms (Galbraith 1973). Internal integration, however, provides mechanisms to afford efficiencies through greater immediacy and breadth of information processing, while preserving some degree of departmental specialization and autonomy (Chen et al. 2007). Integration mechanisms serve to automate or eliminate cross-departmental transactions and data translations, and similarly reduce other process "wastes" associated with functional silos (Swink et al. 2007); for example, both planning and execution processes involving various stakeholders can be streamlined. As a result we expect reductions in overhead costs associated with the management of inter-departmental communications and indirect costs associated with planning and coordination. In addition, we expect that direct costs of execution will be lowered by internal integration through a higher quality of planning. For example, more integrated planning processes (e.g., sales and operations planning) foster more complete goal alignment and more global resource optimization, leading to lower processing costs. Thus, internal integration should yield greater process efficiencies (ROS) as reflected in COGS and SG&A.

In addition, a central tenet of IPT is that information processing capacity is necessitated by uncertainty and interdependence, which work together to create "unexpected events" and "exception scenarios" (Galbraith 1973). An organization can invest in slack resources to buffer itself against these incidents. However, it is often better off when it uses lateral and vertical mechanisms to reduce uncertainty and to rationalize interdependencies, thus preventing unexpected problems that require work-arounds (Galbraith 1974). For example, communication of, and commitment to, a single plan (as opposed to independently developed departmental plans) should lead to more internally consistent and synchronized actions (e.g., purchases and production schedules), thereby eliminating process costs associated with responses to

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[1] ROA = ROS × ATO.

unexpected events (Sheremata 2000). Such costs include expediting, rework, costs associated with raising and lowering resource capacities, and other transition costs. Global, integrated optimization also promotes balance across decisions made in departments with incompatible metrics and goals. For example, production functions typically pursue large batch schedules and low inventories, while logistics functions emphasize small batches and high service levels (Pyke and Cohen 1993; Arshinder and Deshmukh 2008). We posit that internal integration enables information processing required to balance such competing objectives. In these ways, internal integration should lead to greater process efficiencies.

H_2: *Internal integration is positively associated with process efficiency (ROS).*

In contrast to ROS, ATO is regarded as an indicator of productivity (Kinney and Wempe 2002). As such, ATO is improved by more productive uses of assets, both current assets (e.g., cash, inventory) and fixed assets (e.g., plant, property, and equipment). ATO is essentially an output-over-input productivity measure (Sales/Assets). We suggest that internal integration enables improved utilization of both current and fixed assets, thus producing greater ATO.

Our arguments are founded in IPT's premise that internal integration is a substitute for buffers needed to protect an organization from detrimental events stemming from uncertainty and unrecognized interdependencies (Galbraith 1974). Through improved planning processes and greater coordination of departmental plans and actions, internal integration likely lowers the need for asset buffers such as cash and inventory (Swink et al. 2007). For example, we suggest that cross-departmental joint planning and coordination should lead to less volatile cash flows in purchases, as well as less uncertainty in both demand and supply. Hence, safety stocks of cash and product inventories could then be reduced. Fewer current assets (cash and inventory) would be needed to hedge against uncertainties, poor or incomplete planning, forecast errors, and so on. In essence, enhanced visibility and associated ability to better plan and forecast via internal integration is exchanged for inventory (cf. Wang and Wei 2007). According to the tenets of IPT, this is accomplished via effective information processing and sense-making that occurs via internal integration.

In the same way, we suggest that more complete planning made possible through internal integration should produce production and logistics schedules that allow asset managers to more fully utilize existing fixed assets. Consistent with IPT, faster, more complete, and more accurate information processing capacity gives asset managers more advanced notice of the need to scale asset resources up or down (cf. Wang and Wei 2007), leading to better overall utilization over time. Better decision making is enabled by a reduction in bounded rationality achieved via internal integration—a better mutual understanding and comprehension can be accomplished (Sheremata 2000). Internal integration also gives asset managers a voice in demand and supply planning, thereby enabling them to veto or modify decisions that would lead to rapid shocks or other volatilities that create extreme loads on productive assets. In these ways, internal integration provides for creativity and coordination mechanisms

(Galbraith 1974) that should lessen the need for buffer capacity, and lead to higher levels of asset productivity.

H_3: *Internal integration is positively associated with asset productivity (ATO).*

According to the above arguments, internal integration provides greater connectivity and coordination across firm functions (Galbraith 1974). We would expect that these benefits are more important in organizations that comprise greater levels of supply chain process span. Akin to the notion of vertical integration, process span reflects the breadth and diversity of business activities conducted by a firm (Swink and Way 1995). From a supply chain perspective, process span is evident in the breadth of supply chain activities (i.e., manufacturing, distribution, retailing) in which the firm is engaged. Since the internal organizations of firms with greater process span include a broader mix of disparate business activities and associated functional perspectives (Swink and Way 1995), we suggest that the potential benefit of internal integration is greater in these settings.

Our argument is grounded in IPT's notion that internal integration is motivated by the desire to reduce bounded rationality (Bergh 1998). Personnel who work in different functions occupy different thought worlds, pursue different objectives, and have different priorities. They are *boundedly rational* (Williamson 1985), meaning they have biased preferences, and they lack full information when making decisions. Personnel occupying more disparate business activities are likely to have more disparate scopes of rationality. For instance, managers of retail operations have different perspectives than managers of manufacturing operations. Since internal integration enables an organization to better synthesize information, put it into context, and facilitate more comprehensive decision-making, it works to reduce bounded rationality (Alexander 1991).

Several researchers point to internal integration as a remedy for the bounded rationality of organizational actors in firms whose operations encompass broad sets of processes (Chikan 2001; Schoenherr and Swink 2012). For example, Chikan (2001) argues that internal integration makes operations smoother by decreasing internal transaction costs associated with managing diverse, interdependent functions. Pagell (2004) argues that, by improving information flows, collaborations, and awareness of functional interdependencies and biases, internal integration fosters better intra-firm, cross-functional goal alignment and better utilization of each function's strengths and competencies. Consistent with IPT, the "processing" of information is enhanced.

Our rationale is further grounded in the belief that, in a context where one can influence more value-adding processes (i.e. with greater process span), the benefits of internal integration for greater performance are magnified (since much more can be positively effectuated by enhanced visibility and coordination made possible via internal integration). A greater breadth of activities is integrated, and associated information is shared, enhancing the decision making capabilities of supply chain managers, likely yielding better performance. Parallels can be found in prior research that has associated a greater span of control with an increase in the volume of decision inputs (Melnyk et al. 2004). Support is also provided by studies that have postulate the benefits of integration between marketing and logistics (Chen et al.

2007), and between logistics and production (Gimenez and Ventura 2005).

Finally, a firm that controls a variety of supply chain activities may be more prone to divisionalize tasks (e.g., have the manufacturing function separate from the distribution function). We expect that, in environments characterized by wider process span, the potential derived via internal integration is magnified, due to the ability to beneficially impact many more functions and constituents. A shared understanding can be developed across the functions, and task coordination can be enhanced (Stank et al. 1999). Such information processing capacity can even break down the "silo" mentality and reduce tendencies for local optimization, thus enabling more global optimization (Lawrence and Lorsch 1967). Through internal integration, functional specialists obtain a broader and more informed picture of firm processes and objectives (Keller 2001), and are more likely to understand and utilize firm resources located in different departments (these represent key benefits postulated by IPT). Accordingly, we expect that the benefits of internal integration are magnified when a firm's activities span a broader set of supply chain operational processes.

     H_4: *Supply chain process span positively moderates the association of internal integration with (a) firm profitability (ROA), (b) process efficiency (ROS), and (c) asset productivity (ATO).*

METHODOLOGY

Data collection and sample

The foregoing hypotheses are tested by making use of both primary and secondary data sources. We analyze primary data collected in multiple rounds of the Global Survey of Supply Chain Progress, administered in 2007, 2008, and 2011 (surveys conducted in other years did not include internal integration variables). These surveys were co-sponsored by the authors, the Council of Supply Chain Management Professionals, Computer Science Corporation, and the magazines *Supply Chain Management Review* and *Supply Chain Europe*. In addition, we matched the survey data with the firms' financial records found in COMPUSTAT, a database containing financial information on publicly traded firms.

Survey invitations were sent to supply chain executives and managers in procurement, operations, and logistics functions drawn from readers of the *Supply Chain Management Review*, clients of the Computer Sciences Corporation's supply chain consulting division, and a list of former participants of supply chain executive education programs at a large Midwestern university. The survey was further advertised on the journal and participating corporate websites. A total of 609 usable responses were received, 141 for 2007, 262 for 2008, and 206 for 2011.

Survey respondents' firms were matched to their financial records in COMPUSTAT. The availability of data was limited due to the fact that some of the survey respondents did not provide company name information, and many were from privately held and/or non-U.S. firms. Nevertheless, a total of 115 respon-

dents could successfully be matched to their firms' financial records. The distribution of records across the three years of data collection is 30 unique companies from 2007, 32 unique companies from 2008, and 47 unique companies from 2011. Six companies were represented in more than one year; we averaged the responses for these six observations.

Overall, the sampled firms represent many different industries; the largest categories include process manufacturing (13.9%), consumer goods (10.4%), discrete manufacturing (11.3%), and retail (13.9%). A total of 73.0% of the firms were involved in manufacturing, 32.2% were involved in retail, and 73.9% were involved in distribution. All respondent firms were involved in at least one of these three supply chain activities, and 39.1% also identified additional business activities in which they were engaged (e.g., services, research and development/design). The sample includes a wide range of firm sizes; annual sales ranged from \$12M to \$393B. Quartile cutoffs were \$2.1B, \$7.9B, and \$24.9B, respectively.

Respondents to the survey were supply chain executives embedded in firms located throughout the world. Based on the key informant approach, we screened the responses and eliminated informants whose titles were not directly related to a supply chain function (Wall et al. 2004). We obtained responses from individuals holding a range of managerial positions, including executive managers (C-level executive, Executive Vice President, Senior Vice President, and Vice President—29.6%), upper managers (Senior Director, Director, Head—36.5%), managers (Senior Manager, Manager—24.3%), and various other positions (Analyst, Buyer, Planner, Specialist—9.6%). This distribution indicates that a large majority of respondents (90.4%) held a rank of manager or higher, suggesting that they have relevant knowledge regarding the survey content.

Based on the survey design, the total number of contacted potential respondents who met our criteria is unknown, making the calculation of a response rate not possible. Therefore, we used respondent data and general industry information to assess response biases and sample representativeness. Specifically, in a first test we compared the mean ROA values of the sampled firms with their respective industry median values; the difference was not statistically significant ($p = .474$). In a second test we assessed differences in the responses for all measurement items across early (first 25%) and late respondents (last 25%) in each survey (Armstrong and Overton 1977). Again, none of the differences were statistically significant. Hence, we conclude that nonresponse bias is not a serious concern.

Measures

Measures for internal integration were collected via the survey. Our work focuses on the role of internal integration in managing on-going supply chain planning and execution; we therefore omit integration efforts related to product development and technology innovation (e.g., Handfield et al. 1999; Dröge et al. 2004; Koufteros et al. 2005, 2010; Narasimhan et al. 2010). The items for our study, which were adapted from prior research (Narasimhan and Kim 2002; Koufteros et al. 2005), assess the extent to which intra-firm functional teams (operations, logistics, sales, marketing, supply management) work together to accomplish supply chain planning and execution (Schoenherr and Swink 2012). As

such, they tap directly into the underlying notions of IPT as articulated by Galbraith (1973, 1974). Respondents were presented with a set of statements to which they were asked to indicate their degree of agreement on a 5-point Likert scale (Appendix B).

To measure supply chain process span, the surveys assessed the simultaneous ownership of several SCM activities, including manufacturing, distribution, and retail (Stearns et al. 1995). We asked respondents to indicate whether manufacturing, distribution, and retail activities, respectively, were conducted by the firm. We computed a process span score of 1, 2, or 3 based on the number of activities conducted by the firm.

For the dependent variables, we computed ROA, ROS, and ATO values using data supplied by the COMPUSTAT database. ROA is calculated as operating income (Sales—COGS—SG&A expense) divided by total net assets. Note that we ignored expenses such as taxes, depreciation, and extraordinary items in order to assess operating performance more directly, and to limit the possibility of outliers due to extraneous causes (Hendricks and Singhal 1997). ROS is calculated as operating income divided by sales. ATO is calculated as sales divided by total net assets. In order to explore the components of these performance ratios, we also computed gross margin (GM = 1—COGS/Sales), the margin for selling, general and administrative expenses (SGAM = 1—SG&A/Sales), current asset turnover (CAT = Sales/Current Assets), and the plant, property, and equipment proportion of fixed asset turns (PPET = Sales/Net Plant, Property, and Equipment). In order to account for variances in these measures over time, we computed an average for each of the performance scores for each respondent over two years, the year of the survey and the immediate subsequent year. Averaging over two years helps smooth out some of the variance in performance due to general economic conditions in any given year. To control for industry differences, we adjusted each of the dependent variable scores for each company by subtracting the median value of each variable for all the companies listed in the sample company's industry (three-digit Standard Industrial Classification). Thus, adjusted $ROA_i = ROA_i - ROA_{median}$.

In addition to these primary variables, several control variables were collected, via both the survey and the COMPUSTAT database. To control for firm size and time frame of the data, we included the log-transformed sales of the company, and two dummy variables indicating the year in which the survey was conducted. To control for halo effects, we included a survey question asking the respondent to indicate his/her firm's overall level of supply chain competence, relative to other firms in the industry. In addition, we included a three-item scale asking respondents to indicate their firm's usage level of information technologies (see Appendix B). Controlling for these factors helps to separate the effects of achieved internal integration from respondents' overall positive feelings about the organization, and from the effects of supporting infrastructural technologies.

To further isolate the contribution of internal integration from extraneous effects, we controlled for supplier integration and customer integration (Flynn et al. 2010). Supplier integration refers to coordination and information sharing activities with key suppliers, leading to, for instance, more effective planning and forecasting (Bowersox et al. 1999; Ragatz et al. 2002). Customer

Table 1: Confirmatory factor analysis results

Construct	Variable	Loading	Std. Error	Critical ratio	R^2
Internal	II1	.729	–	–	.531
integration	II2	.749	.187	5.796	.560
α = .873	II3	.728	.175	5.638	.530
CR = .891	II4	.789	.195	6.097	.622
AVE = .578	II5	.633	.180	4.900	.401
	II6	.759	.190	5.870	.575
Supplier	SI1	.652	–	–	.425
integration	SI2	.870	.209	5.486	.757
α = .827	SI3	.655	.198	4.557	.430
CR = .861	SI4	.653	.223	4.542	.426
AVE = .557	SI5	.678	.209	4.686	.460
Customer	CI1	.756	–	–	.572
integration	CI2	.772	.279	5.789	.595
α = .785	CI3	.777	.224	5.828	.604
CR = .827	CI4	.428	.243	3.239	.183
AVE = .500	CI5	.573	.214	4.354	.329

Note AVE, average variance extracted; CI, customer integration; CR, composite reliability; II, internal integration; SI, supplier integration.

integration is defined as close collaboration and information sharing with key customers, yielding strategic insight into market expectations and enabling a more efficient and effective response to customer needs (Swink et al. 2007; Wong et al. 2011). Items for supplier and customer integration were adapted from prior research (Koufteros et al. 2005; Li et al. 2005; Swink et al. 2007), and assessed the degree to which more involved, synchronized and proactive relationships are sought with suppliers or customers (Schoenherr and Swink 2012). These two variables were included only in the 2007 and 2008 surveys.

Finally, we recognized the potential mismatch between the reporting units for the surveys and for the financial data. The financial data represent performance for the entire firm, whereas survey respondents may have given information pertaining to all or only a part of the firm. To control for this effect, we included a question asking the respondent to indicate the organizational level that his/her responses represented (see Appendix B). This question, which we used as a control variable in a robustness test, was included only in the 2007 and 2008 surveys.

Validity and reliability of the multi-item scales were assessed via approaches suggested by Anderson and Gerbing (1988). Specifically, the adaptation of the measurement items from extant research, and their subsequent refinement with academics and industry professionals, ensured content validity. The coefficients estimated from the sample data loaded significantly on their underlying construct, being indicative of convergent validity (Table 1). Discriminant validity was established by the square-roots of the average variance extracted (AVE) being greater than the corresponding correlations. Reliability was provided by satisfactory Cronbach's alpha and composite reliability values. A composite score was computed for each factor by averaging the scores of the factor items. Summary statistics and correlations are provided in Table 2.

Table 2: Summary statistics and correlations

	Mean	Std Dev	1	2	3	4	5	6	7	8	9	10	11
1. adjROA	−.014	.176	1										
2. adjROS	.042	.315	.733***	1									
3. adjGM	.082	.287	.543***	.798***	1								
4. adjSGAM	−.043	.193	.380***	.433***	−.197*	1							
5. adjATO	.084	.733	.168+	−.080	−.169+	.124	1						
6. adjCAT	.172	1.459	.463***	.201*	.022	.291**	.560***	1					
7. adjPPET	3.340	15.489	.303**	.066	.020	.079	.058	.229*	1				
8. Internal integration	3.185	.768	.288**	.222*	.170	.116	.170+	.091	.100	1			
9. SC process span	1.843	.633	.159	.152	.192*	−.039	−.025	.172+	.206*	.065	1		
10. LogSales	3.845	.842	.119	.090	−.121	.328***	.058	.116	.428***	.159+	.159+	1	
11. Technology use	2.075	.557	−.013	−.034	−.005	−.038	.135	.083	−.042	.264**	.013	.177+	1
12. SC competence	3.346	1.069	.101	−.011	−.057	.065	.258**	.068	−.101	.362***	.039	−.033	.379***

Notes: ATO, asset turnover; CAT, current asset turnover; GM, gross margin; PPET, plant, property, and equipment turnover; ROA, return-on-assets; ROS, return-on-sales; SC, supply chain; SGAM, selling, general, and administrative expenses margin.
***p < .001, **p < .01, *p < .05, +*p* < .1.

STATISTICAL ANALYSIS AND RESULTS

We use ordinary least squares regression analyses to test our hypotheses. Table 3 summarizes the results for the regression models. For each dependent variable, three regression models are presented: model 1 includes the control variables, model 2 adds the main effects of process span and internal integration, and model 3 adds the interaction between process span and internal integration. We remind the reader that all dependent variables have been adjusted by subtracting industry median values in order to control for extraneous industry effects.

Hypothesis tests

H_1 suggests that internal integration is positively associated with ROA. In model ROA2, the standardized beta coefficient of internal integration is positive and highly significant (β = .330, p < .01), providing strong support for H_1. Regarding the control variables, only the survey year dummy variables are significant, being positively associated with ROA. The R-squared for the model is 20.4%. We consider this amount of explained variance to be substantial, especially given the wide number of potential contributors to overall firm profitability. In addition, the F-value indicates that the model is highly significant.

H_2 suggests a positive and significant influence of internal integration on ROS, which represents the efficiency aspect of overall firm performance. The results provide support for H_2, as the coefficient in model ROS2 is significant (β = .263, p < .05). As before, the survey year dummies are the only control variables that are significant in the ROS models. The R-squared value for the ROS2 model is 14.1% (again a substantial amount of explained variance) and the F-value indicates that the model is significant.

H_3 posits a positive influence of internal integration on productivity, as measured by ATO. This relationship is not supported by our data (β = .072, *ns*). While the R-squared value for the ATO2 model is 9.7% (driven by the time frame control variable for 2008), the F-values indicate that the model is not statistically significant.

$H_{4a–c}$ state that supply chain process span positively moderates the effects of internal integration on each of the foregoing performance variables, respectively. Model ROA3 in Table 3 shows that the interaction of process span and internal integration is positive and significant (β = .210, p < .05), thus supporting H_{4a}. The model also experienced a significant increase in variance explained, with the R-squared value of ROA3 being 24.5%. The comparable coefficients in models ROS3 and ATO3 are not significant, and provide no support for H_{4b} and H_{4c} (variance explained did not improve for both models, and was at 15.0% and 11.2%, respectively).

Exploratory tests of associations with components of efficiency and productivity

To bring further insight into how internal integration might affect the underlying process structures that drive ROS and ATO, we assessed the influence of internal integration on their major components. For ROS, these components include mid-level profit measures addressing two major cost/expense categories, GM

Table 3: Regressions of adjusted return-on-assets (ROA), return-on-sales (ROS), and asset turnover (ATO) on predictors

	ROA1	ROA2	ROA3	ROS1	ROS2	ROS3	ATO1	ATO2	ATO3
LogSales	.161	.088[+]	.074	.146	.086	.081	.050	.046	.056
Year08	.265*	.281*	.265*	.196[+]	.214[+]	.207[+]	.225*	.226[+]	.229*
Year11	.230*	.251*	.242*	.243*	.264*	.260*	.037	.031	.030
Technology use	−.108	−.150	−.151	−.062	−.095	−.095	.053	.044	.045
SC competence	.154	.043	.072	.012	−.077	−.063	.190	.164	.147
SC process span		.154[+]	.114		.151	.131		−.046	−.026
Internal integration		.330**	.323**		.263*	.259*		.072	.080
SC process span × Internal integration			.210*			.103			−.127
R-squared	.089	.204	.245	.059	.141	.150	.091	.097	.112
Adjusted *R*-squared	.042	.146	.182	.011	.079	.080	.046	.032	.039
F	1.913[+]	3.518**	3.862***	1.240	2.266*	2.126*	2.010[+]	1.503	1.533

Notes: SC, supply chain.
***$p < .001$, **$p < .01$, *$p < .05$, [+]$p < .1$.

Table 4: Regressions of components of return-on-sales: adjusted gross (GM) margin and adjusted sales, general, and administrative expense (SGAM) margin, on predictors

	GM1	GM2	GM3	SGAM1	SGAM2	SGAM3
LogSales	−.112	−.174[+]	−.173[+]	.238*	.243*	.236*
Year08	.049	.068	.069	.227*	.226*	.215*
Year11	.164	.192[+]	.192[+]	.261*	.256*	.250*
Technology use	.029	.007	.007	−.048	−.053	−.053
SC competence	−.070	−.158	−.160	−.062	−.066	−.033
SC process span		.221*	.226*		−.048	−.096
Internal integration		.235*	.236*		.027	.018
SC process span × Internal integration			−.022			.219*
R-squared	.040	.137	.137	.099	.102	.146
Adjusted *R*-squared	−.004	.080	.072	.057	.042	.081
F	.916	2.417*	2.103*	2.349*	1.697	2.229*

Notes: SC, supply chain.
*$p < .05$, [+]$p < .1$.

(i.e., 1 − Cost of Goods Sold/Sales) and SG&A expense margin (SGAM). Table 4 provides regression results for these two measures of cost efficiency. Interestingly, the results indicate that internal integration is significantly associated with improved GM (see models GM2 and GM3). However, the interaction of internal integration with supply chain process span is significantly positive only for SGAM (see model SGAM3).

We further investigated relationships between internal integration and components of ATO that measure productivities of two primary asset classes, CAT and PPET. The results, shown in Table 5, indicate that the influence of internal integration on CAT is not significant. Similarly, the association of internal integration with PPET is also not statistically significant.

Robustness test

As a robustness check of the findings against possible confounds and sampling issues, we repeated the regression analyses for adjusted ROA, this time adding three additional control variables. Some firms may pursue multiple integration efforts simultaneously. Accordingly, we added controls for customer and supplier integration. As mentioned in the Methodology section above, we also recognized the possibility of reporting effects due to mismatches between the unit for which the respondents reported and the unit for which financial data were available. To address this issue, we included the control variable for organizational reporting level. Data for these control variables were only available in the 2007 and 2008 surveys, so the analyses are limited to those samples. However, the test using this subset of the data allows a check of the robustness of the results to sampling issues.

Table 6 shows the regression results. None of the additional control variables are significant. However, the main and interaction effects of internal integration on adjusted ROA remain strongly significant. These findings suggest that the support for the hypotheses is robust to the identified issues.

Table 5: Regressions of components of asset turnover: current asset turnover (CAT) and plant, property, and equipment turnover (PPET), on predictors

	CAT1	CAT2	CAT3	PPET1	PPET2	PPET3
LogSales	.150	.114	.118	.023	.037	.041
Year08	.203$^+$	.213$^+$	.216$^+$	−.078	−.089	−.087
Year11	.121	.141	.142	−.281*	−.318**	−.318**
Technology use	.041	.036	.035	.039	.021	.021
SC competence	.013	−.023	−.032	.222*	.177$^+$	.169
SC process span		.178$^+$	.192$^+$		−.229*	−.221*
Internal integration		.080	.083		.141	.144
SC process span × Internal integration			−.063			−.053
R-squared	.044	.081	.085	.120	.182	.185
Adjusted *R*-squared	.000	.021	.015	.075	.123	.117
F	1.006	1.341	1.221	2.699*	3.083**	2.716**

Notes: SC, supply chain.
**$p < .01$, *$p < .05$, $^+p < .1$.

Table 6: Regressions of return-on-assets (ROA) on predictors including additional control variables, 2007 and 2008 data only

	ROA1	ROA2	ROA3
LogSales	.115	.029	.012
Year08	.341*	.405**	.384**
Organizational level	−.080	−.035	−.031
Technology use	.115	.099	.112
SC competence	−.175	−.172	−.140
Customer integration	.214	.025	.009
Supplier integration	−.069	−.158	−.112
SC process span		.103	.100
Internal integration		.434**	.381**
SC process span × Internal integration			.237*
R-squared	.181	.317	.368
Adjusted *R*-squared	.082	.207	.253
F	1.827***	2.886**	3.201**

Notes: SC, supply chain.
***$p < .001$, **$p < .01$, *$p < .05$.

DISCUSSION AND IMPLICATIONS

We designed this study to extend prior research and practice pertaining to internal integration. While the importance of internal integration is largely unquestioned, much scholarly work on internal integration has been descriptive, has offered limited theoretical development, and has failed to provide strong evidence for the relationship between internal integration and profit. In addition, managers feel that actual practice has much room for improvement (Poirier et al. 2008). Within this context, we add rigor and relevance to the study of internal integration by measuring achieved internal integration, by deeply grounding our expectations in IPT, by investigating the direct effect of internal integration on performance using objectively reported financial metrics, and by studying the contingency of supply chain process

span. Two of our hypotheses are supported, one is partially supported, and one failed to receive support. The insights from these findings, as described below, provide intriguing implications for the applicability of IPT to the study of internal integration. Of particular interest is the differentiated impact of internal integration on various financial performance measures, enabling us to propose a more specific theory of internal integration through the lens of IPT.

Grounding our expectations in IPT, we first theorized the positive association of internal integration with profitability, measured by ROA (H_1). The data strongly support this hypothesis, consistent with the assertion that enhanced information processing capabilities are provided by internal integration (Galbraith 1973). Internal integration is achieved when supporting organizational infrastructures and processes enable the effective and accurate processing of information, including its dissemination to appropriate constituents within the firm. This enhances visibility, reduces uncertainty, and enables effective decision making. Integration mechanisms, such as the use of teams, also provide for give-and-take discussions of new information; thus clarifications can be made, equivocality can be addressed, and bounded rationality can be overcome. Through processing information in these ways, more comprehensive situation assessments can be made, better deployments of resources can be initiated, functional goals and plans can be better aligned, and redundancies and uncertainty buffers can be reduced. In these ways, profitability (ROA) can be increased.

In order to add rigor and relevance to the investigation of internal integration's impact on ROA, we sought additional insight into the financial evidence for the various benefits identified above. Accordingly, we independently theorized and tested the positive association of internal integration with ROA's components: ROS (H_2, process efficiency) and ATO (H_3, asset productivity). The support for our second hypothesis suggests that internal integration produces greater planning and process efficiencies, as evidenced by higher levels of ROS. Infrastructural mechanisms afforded by internal integration can streamline, improve, and potentially automate information flows,

thus reducing both direct execution costs and indirect overhead costs.

Our fine-grained analyses provide evidence of integration benefits for both direct and indirect cost elements, as reflected in higher GM and SGAM, respectively. The GM finding demonstrates the positive influence of internal integration on the percent of total sales revenue the firm retains after considering all COGS. This comports well with the efficiency arguments founded in IPT; internal integration offers information processing mechanisms that enable the firm to operate more efficiently, thus lowering direct costs. In contrast, the efficiency effects of internal integration on SGAM appear to be significant only for firms that operate broader sets of supply chain business processes. From an IPT perspective, this again makes sense; where GM is primarily a measure of the efficiency in the usage of direct resources (material purchases and direct labor expenses), SGAM reflects efficiencies in indirect processes, including the management of transactions, coordination costs, overhead costs, and indirect labor costs. It seems sensible under an IPT perspective that indirect costs are raised by the number of different business processes that the firm manages, as the number and breadth of uncertainties are raised, and the potential for competing functional biases (bounded rationality) is heightened. Information processing capacity provided by internal integration is therefore likely to be more important in broad-span firms, as a means to manage these added challenges.

Collectively, these findings suggest that, for firms with both narrow and wide scopes of process span, operating process efficiencies gained through internal integration apply to direct cost savings in areas of purchase costs, direct labor costs, logistics costs directly attributable to specific products, and other elements of COGS. The IPT perspective suggests that these direct cost savings reflect greater process efficiencies from more accurate, consistent, and synchronized actions across procurement, production, and delivery. However, firms that engage in wider sets of business activities might also expect to see benefits from internal integration in areas of indirect costs, which include corporate overheads, managerial salaries, systems costs, and other elements of SG&A. Greater information processing capacity is thought to make the transactional and coordination processes that absorb these types of costs more efficient. The importance of our contribution lies in the confirmation of the logical arguments developed and grounded in IPT, offering a level of theorizing that delves deeper into the underlying rationales. Specifically, we have identified an important boundary condition pertaining to the applicability of IPT. Benefits derived from information processing capabilities materialize in greater SGAM only among firms with greater process span, due to their need to coordinate across a broader mix of functions.

Our findings for process efficiency gains are in line with foregoing researchers that have suggested the boundary-spanning nature of internal integration improving the interface between functions (e.g., Swink et al. 2007; Schoenherr and Swink 2012). The IPT suggests that this can be accomplished through the use of specific rules and programs, or by creating lateral relations through teams, liaison roles, and social networks (Galbraith 1974). The formal nature of such structures enables the sharing of information across functional boundaries, while at the same time upholding departmental independence. All these efforts serve to reduce uncertainty regarding environmental and competitive conditions, and uncertainty in cross-departmental interdependencies. In addition, cross-departmental interactions and data flows can be streamlined, reducing organizational redundancy and duplication of effort. Increased visibility in company processes and available information enables more cohesive and coordinated decision making, and better planning, reducing non-value-added activities. The cumulative effect of associated efficiency gains across affected processes is to lower operating costs, and thus improve ROS.

Our third hypothesis, which theorized the effect of internal integration on asset productivity, is not supported by the data. This is true for the ATO measure, as well as for the underlying productivity elements that we explored, that is, CAT and PPET. We based our expectations on the IPT-inspired argument that more integrated planning processes should lower the need for buffer assets, and also enable higher levels of asset utilization (Narasimhan and Kim 2002; Rodrigues et al. 2004; Wong et al. 2011). An explanation for the lack of a significant finding may be that structural changes to physical assets are necessary to effectuate asset productivity improvements, and managers are either reluctant to make these changes, or are unaware that they can do so. For example, changes to plant, property, and equipment are not made easily or quickly, they typically occur in large chunks, and they take time to ramp up. While managers may observe steady, incremental improvements to direct and indirect costs as internal integration grows and planning improves, they may find it more difficult to implement step-function changes to physical capacity needed to attain capital cost improvements. We might expect that changes to current asset levels (inventories and cash) would be easier to make, yet opportunities for lowering such buffer assets might go unrecognized. Policy changes in these areas might also be resisted by personnel (e.g., marketing in the case of inventory, and finance in the case of cash) who view the changes as risky, especially if drops in uncertainty levels are not readily apparent. Overall, costs of capital are not as visible as costs of labor and materials, and so improvements to asset productivity may lag more transparent improvements to process efficiencies. It would be interesting for future research to examine our speculations regarding these effects. The larger implication that should be examined in future research is that internal integration benefits appear to apply more towards efficiency gains, rather than toward asset-oriented productivity gains.

Our fourth hypothesis received mixed support. While supply chain process span positively moderated the relationship between internal integration and ROA, the moderation effect was significant for none of the more specific cost elements, except for SGAM. As we explained above, the moderation effect of process span makes good sense as it pertains to SG&A processes, as these are the indirect and overhead processes that must often consolidate and rationalize inputs from varied business functions. It is not possible to determine whether these SGAM benefits account for all of the significant moderating effect at the ROA level, or if other small effects in other cost categories also accumulate to drive the significant ROA result. We can say that the impacts of process span seem to be most salient in the elements associated with SG&A.

Table 7: Observations, calls to action, and future research

Observations	Calls to action and future research
Internal integration is positively associated with ROA and ROS	• Does internal integration contribute to the generation of a supportive company culture that creates greater ROA/ROS? • What other (less obvious) benefits can be derived from internal integration that have not been investigated?
Internal integration is not associated with ATO	• Are asset productivities slower to develop as a result of internal integration, or are the effects truly not significant? • Are certain internal integration practices more effective in generating certain performance outcomes than others? For example, is formal internal integration more effective than informal internal integration? • What internal integration practices are impacting which performance outcomes, and why? A more detailed investigation of specific practices and performance outcomes is needed
Selective moderation of process span	• What other factors moderate the relationship between internal integration and performance? • Can additional mediating and moderating variables explain prior counterintuitive and contradictory findings?
Applicability of IPT	• What are the specific effects of reductions in uncertainty, equivocality, and bounded rationality? Do these factors impact process efficiency more than asset productivity? • Are there competing theories that would better explain these effects? • Do IPT arguments also apply to external integration? • What would IPT say about other outcomes of internal integration such as organizational flexibility and changes to corporate culture?

Note: ATO, asset turnover; IPT, information processing theory; ROA, return-on-assets; ROS, return-on-sales.

Our post hoc analysis provides another interesting result. While the effects of internal integration remain significant and substantial, effects of external integration appear to be mostly non-significant (at least in the subset of data for which we had measures of external integration). The apparent differences in effects of internal versus external integration uncovered in this study suggest the need for future research to make comparative examinations of the independent and potentially interacting effects of different integration efforts on financial performance.

Significant variation in the levels of achieved integration represented in our sample suggests that integration opportunities are often either ignored or are difficult to achieve. This is in line with recent studies that argued for internal integration requiring significant organizational commitment (Ellinger et al. 2006; Richey et al. 2010). As such, our finding solidifies the potential for internal integration as a distinctive source of advantage.

From a meta-theoretical perspective, our study adds both rigor and relevance to prior research that has investigated the influence of internal integration on performance. Most importantly, prior studies have consistently employed only perceptual measures of performance, collected via surveys (van der Vaart and van Donk 2008; see Appendix A for empirical studies). For example, respondents were asked to indicate whether they judged their performance as being above or below the industry average (e.g., Germain and Iyer 2006). We complement this inherently subjective measure in the present research by objective financial data from firms' financial records. To the best of our knowledge, the

present research is the first to utilize externally-collected performance measures to assess the impact of integration. This contribution provides empirical corroboration of a concept considered fundamental to SCM, and thus adds rigor to the investigation of internal integration and its effect on performance. As noted by Douglas and Craig (2005) and van Weele and van Raaij (2014), replicatory studies aimed at validating theory in different contexts are essential for ascertaining the predictive validity and generalizability of theory, as well as for ensuring rigor and relevance. From an even broader perspective, our research contributes to the scarce but emerging research in logistics and SCM that considers profit measures drawn from external databases (Melnyk et al. 2004; Ellinger et al. 2011), alleviating concerns pertaining to common method bias.

This study also calls attention to the variety of theoretical lenses (or the lack thereof) that have been drawn upon to develop expectations and explicate findings pertaining to internal integration. Such theoretical diversity can be useful, yet much of the foregoing theory is limited in that it addresses integration effects only vaguely and at rather high levels. Our study provides more concrete logical arguments that apply IPT to potential efficiencies and productivities. Moreover, we use this theoretical lens to formulate specific hypotheses regarding process efficiency and asset productivity, as well as the moderating role of supply chain process span. Prior studies have not addressed performance effects at this level of specificity, nor have they tested such effects using unambiguous financial data. In Table 7, we provide

more specific calls to action for managers and future research opportunities for academics, derived from our findings.

From a practical perspective, we provide evidence for the significant financial value of internal integration, and offer motivation for practitioners to pursue such efforts. We clarified this link with commonly-accepted financial metrics, as called for by Ellinger et al. (2011). The backing of integration benefits by quantifiable results should help practitioners in making the case for the importance of internal integration. The lack of such evidence may explain, at least in part, deficiencies in internal integration perceived by managers (Poirier et al. 2008).

Our results suggest that the potential effects of internal integration are quite substantial. The data indicate that a firm that has a level of internal integration one standard deviation higher than other firms enjoys a 6.7 percentage points larger GM, an 8.2 points larger ROS, and a 5.7 points larger ROA. These values represent 25%, 76%, and 57% improvements over the sample average values of these profitability metrics, respectively. Hence, our results suggest that considerable improvements in profits can come from greater internal integration. The promise of such gains should offer further motivation for managers to pursue process efficiencies from related investments.

Our findings serve as a call to managers, especially to those who already "believe" in the value of internal integration, but who lack company support for implementation of the necessary organizational and technological changes. Our study provides hard evidence for the financial benefits of internal integration. In addition, our findings suggest that managers should look, at least initially, for improvements in direct process costs (COGS) as a result of internal integration, and recognize that asset productivities and associated capital cost improvements may take longer to materialize, if at all. Accordingly, we would expect improvements to show up on the income statement more than on the balance sheet. Because the creation of integration structures (relationships and systems) mainly affects intangible factors (information flows, planning, decision making, cross-functional relations), managers will need to make measurements of integration impacts intentional, tracking improvements in cost outcomes, but also evaluating changes in the quality of planning and collaboration across functions. We suggest that both types of measures are needed in order to build an appreciation of integration's full effects, and to estimate its true return on investment. We thus issue a call to be persistent in the pursuit of internal integration, as the financial rewards appear to be substantial.

CONCLUSION

Most scholarly work in the domain of internal integration has been descriptive and theoretically underdeveloped (Frankel and Mollenkopf 2013). In addition, no previous research has utilized externally collected financial data to assess the impact of integration. Furthermore, while supply chain managers perceive their companies to have reached proficient levels of external integration, this is not the case for internal integration (Poirier et al. 2008). We have aimed to overcome limitations in extant research, and have answered the question of whether internal integration concretely affects financial performance. Our hypotheses on the effects of internal integration on performance metrics are grounded in IPT. Accordingly, we theorized and confirmed the positive influence of internal integration on profitability (ROA) and related process efficiencies (ROS, GM, and SGAM). This corroborates expectations inherent to IPT, and provides practical motivation for managers. However, our arguments associating internal integration with improved asset productivity are not supported. We provided possible explanations for this result.

Although this research significantly advances the rigor and relevance of internal integration research within the logistics and SCM domain, its contributions are tempered by its limitations, which also provide opportunities for future research. First, our sample relies mostly on large, publicly-traded U.S.-based firms, and the results are therefore not necessarily transferable to smaller enterprises or firms that are not publicly-traded, or to other countries or cultures. Future research is encouraged to replicate our study in different contexts and countries to identify potential differences. We can imagine, for example, that the degree of individualism/collectivism associated with a certain culture has an influence on the efficacy of internal integration in influencing performance outcomes. Second, our sample is restricted by the limited availability of financial data for only a subset of companies represented in three surveys. We also note the potential mismatch between the reporting units for the surveys and the financial data. While we aimed to control for this mismatch and our results were robust, we recognize this mismatch as a limitation. Future research is encouraged to pursue such study with a more targeted data collection effort, maximizing the participation of publicly-traded firms for which financial data are readily accessible. And third, our data are comprised of firms primarily in manufacturing, distribution, and retail industries. The findings are therefore not necessarily generalizable to other industries. It is our hope that the present research serves as a motivation for further investigation in this area.

APPENDIX A

EMPIRICAL STUDIES OF ASSOCIATIONS BETWEEN INTERNAL SUPPLY CHAIN INTEGRATION (AS AN INDIVIDUAL CONSTRUCT) AND PERFORMANCE

	Operationalization of internal integration	Theoretical foundation	Performance/outcome measures (all perceptual)	Findings
Braunscheidel and Suresh 2009	Frequency and richness of inter-departmental communications	Marketing and learning orientation lead to internal integration	External integration External flexibility Supply chain agility	Internal integration influences external integration and is associated with supply chain agility
Chen et al. 2007	Cross-functional interactions involving working together in teams and sharing resources	Interdepartmental collaboration brings departments into a cohesive organization	Firm performance (amalgam of customer satisfaction, sales, profit margin, return-on-assets)	Marketing/logistics integration is associated with firm-wide integration, which is associated with firm performance
Ellinger et al. 2000	Marketing-logistics effectiveness of interdepartmental relations	Better communication enables more cohesive responses to customer needs	Distribution service Financial performance (amalgam of profitability, sales growth, customer satisfaction)	Internal integration is related to distribution service, but not financial performance
Flynn et al. 2010	Real-time data visibility and information system integration, interdepartmental meetings and teams	Processes are improved by cooperation, information sharing, joint planning	Operational performance (responsive service) Business performance (amalgam of profit and growth measures)	Internal integration is related to both business and operational performance
Germain and Iyer 2006	Collaboration and unified process control through committees, teams, and liaisons	Processes gain efficiencies from reduction in nonvalue-added activities and better information access	Logistical performance (delivery and inventory) Financial performance (amalgam of profit and growth)	Internal integration affects logistical performance both directly and through interaction with customer integration, but it is not directly associated with financial performance
Gimenez and Ventura 2005	Teamwork and joint planning between logistics-production and logistics-marketing	Integration improves interdepartmental relations and coordination	Absolute performance (cost, stock-out, and lead time reductions)	Logistics-production integration is positively associated with performance only for weak collaboration relationships
Lee et al. 2007	Departments have easy access to operational data from an integrated database	No explicit theory	Cost containment Reliability	Internal integration is associated with cost containment

Continued.

Table : (Continued)

	Operationalization of internal integration	Theoretical foundation	Performance/outcome measures (all perceptual)	Findings
Narasimhan and Kim 2002	Real-time data visibility and information system integration, interdepartmental meetings	Economies of scope integration disperses risks from diversity and complexity stemming from unrelated diversification	Sales growth Market share growth Profitability	Internal integration is directly associated with all three performance variables and positively moderates curvilinear relationships between product and market diversification and performance
Rodrigues et al. 2004	Linkage through extensive use of cross-functional teams, information sharing, and process orientation	Integration improves asset utilization through reduced redundancies, economies of scale, and differentiation of core competencies	Logistics performance	Internal integration is not significantly associated with performance
Sanders and Premus 2005	Cross-functional collaboration in planning, integrated database, shared operations information	No explicit theory	Firm performance (amalgam of cost, quality, product introduction, delivery speed)	Internal integration is positively associated with firm performance
Schoenherr and Swink 2012	Personnel from multiple functions work together to accomplish planning and execution	Information processing theory—internal integration provides capability to absorb and exploit information collected via external integration efforts	Quality Delivery Flexibility Cost	Internal integration is directly associated with all dimensions of operational performance. It positively moderates the relationships of external integration to delivery and flexibility performance
Springinklee and Wallenburg 2012	Manufacturing and distribution activities are seamless, aligned, and performed smoothly	Integration enables the rationalization of production and distribution interdependencies	Distribution service	Internal integration is positively associated with distribution service performance
Stank et al. 1999	Frequency of collaborative marketing/logistics interactions	Interdepartmental interactions facilitate responsiveness	Logistics performance Marketing/logistics effectiveness	Certain elements of collaborative integration are associated with logistics performance and marketing/logistics effectiveness

Table : (Continued)

	Operationalization of internal integration	Theoretical foundation	Performance/outcome measures (all perceptual)	Findings
Stank et al. 2001a	Combination of organizational unification, standardization, simplification, metrics compliance, and structural performance improvements	Linking and synchronizing internally-performed processes improves logistical performance	Range of logistics outcomes	Internal integration is associated with overall logistics performance, specifically logistics cost, delivery dependability, order fill capability, and inventory turns
Wong et al. 2011	Collective responsibility across functions via integrated systems and emphasis on information and physical flows	Integration reduces redundancy and wasted resources, facilitates knowledge sharing, allows better coordination of capacity	Quality Delivery Flexibility Cost	Internal integration is directly associated with all dimensions of operational performance. Environmental uncertainty positively moderates the relationship between internal integration and cost and quality performance

APPENDIX B

QUESTIONNAIRE ITEMS

INTERNAL INTEGRATION

Extent to which intra-firm functional teams (operations, logistics, sales, marketing, supply management) work together to accomplish supply chain planning and execution. Please rate your level of agreement with the following statements describing *internal integration activities* (1–5; Strongly agree—Strongly disagree).

a. Functional teams are aware of each other's responsibilities (II1)
b. Functional teams have a common prioritization of customers in case of supply shortages and how allocations will be made (II2)
c. Operational and tactical information is regularly exchanged between functional teams (II3)
d. Purchasing decisions are based on plans agreed upon by all functional teams (II4)
e. All functional teams use common product roadmaps and other procedures to guide product launch (II5)
f. Performance metrics promote rational trade offs among customer service and operational costs (II6)

SUPPLY CHAIN COMPETENCE

How would you rate your firm's overall level of supply chain competence?

1 SCM is not a strength relative to others in our industry
2 Our SCM competence is below the average for our industry
3 Our SCM competence is at about the average for our industry
4 Our SCM competence is above the average for our industry
5 We are one of a few leaders in SCM in our industry

TECHNOLOGY USE

What processes and associated technologies are you using to advance your supply chain evolution and drive results? (1 = little or no usage; 2 = early stages of usage; 3 = we are experienced users)

a. Execution systems/practices (WMS, TMS, ERP)
b. Relationship management systems (CPFR, CRM, SRM)
c. Strategic planning systems (Business & Supply Chain Intelligence, PLM, Network Optimization)

SUPPLY CHAIN PROCESS SPAN

Please indicate all the activities that are included in your firm.

• Manufacturing
• Retail
• Distribution
• Other (please specify)

ITEMS INCLUDED IN 2007 AND 2008 QUESTIONNAIRES ONLY

Supplier integration

Extent to which planning and execution incorporate and are synchronized with suppliers' capabilities. Please rate your level of agreement with the following statements describing *supplier integration activities* (1–5; Strongly agree—Strongly disagree)

a. We pursue supplier relationships and involvement that go beyond operational transactions (SI1)
b. Our plans address individual suppliers' capabilities (SI2)
c. We synchronize our activities with those of key suppliers (SI3)
d. We exchange operational information with suppliers (SI4)
e. We are constantly exploring new working relationships with suppliers (SI5)

Customer integration

Extent to which specific customers and their needs are incorporated into planning and execution activities. Please rate your level of agreement with the following statements describing *customer integration activities* (1–5; Strongly agree—Strongly disagree)

a. We pursue customer relationships and involvement that go beyond sales transactions (CI1)
b. Our plans address individual customer's requirements (CI2)
c. We synchronize our activities with those of key customers (CI3)
d. We have clearly defined roles and responsibilities for managing customer relationships (CI4)
e. We are constantly exploring new working relationships with customers (CI5)

Organizational level

Describe the organization for which you are responding.

- Corporate
- Group, multiple division
- Division, wholly owned subsidiary or SBU (Strategic Business Unit)

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