Paradigms of choice in manufacturing strategy

Exploring performance relationships of fit, best practices, and capability-based approaches

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Received January 2009
Revised August 2009, December 2009
Accepted January 2010

Abstract

Purpose – The paper sets out to test relationships between performance improvements and the three classical manufacturing strategy paradigms of fit, best practices, and capabilities defined by Voss.

Design/methodology/approach – Regression analyses are carried out on an international sample of 697 manufacturers of fabricated metal products, machinery, and equipment.

Findings – The results indicate that capability learning and best practices are positively related to performance improvements in quality, flexibility, and dependability, whereas internal fit appears to be negatively related to flexibility improvements.

Research limitations/implications – The study reinforces the need for research to explore the nature and role of the three paradigms jointly rather than in isolation. In particular, more research is needed to assess the merits of maintaining fit between operations structure and processes.

Practical implications – Improving performance in areas such as quality, flexibility, and delivery can be achieved through building capabilities and/or adopting best practices, but not apparently by maintaining internal fit between operations structure and processes.

Originality/value – The study validates two of the three classical paradigms of manufacturing strategy and makes the case for research to further specify and test the merits of maintaining internal fit between operations structure and processes.

Keywords Operations management, Performance management, Best practice

Paper type Research paper

A previous and shorter version of this paper appeared in the Proceedings from the 15th International Annual EurOMA Conference, Groningen, June 2008.

Giovani J.C. da Silveira's research is supported by the Natural Sciences and Engineering Research Council of Canada (Discovery Grant No. 283134-04) and by the Warren & Marline Dyer Faculty Fellowship in Operations Management at the Haskayne School of Business. Rui S. Sousa's research has been supported by Fundação para a Ciência e Tecnologia (Sabbatical grant no. SFRH/BSAB/819/2008). The authors thank Peter Sherer, James Agarwal, the journal reviewers, and participants at the 2008 EurOMA conference for comments and suggestions on previous versions of this paper.

International Journal of Operations & Production Management
Vol. 30 No. 12, 2010
pp. 1219-1245

0144-3577
DOI 10.1108/01443571011094244

Introduction

There is a long-standing debate in manufacturing strategy over the approaches for product and process choice. Since the late 1970s, researchers have discussed the merits of designing and improving operations based on alternative perspectives such as developing capabilities, adopting best practices (BPs), and maintaining fit.

This debate seems to have first appeared in studies on world-class manufacturing and trade-offs, e.g. Schonberger (1986), Ferdows and de Meyer (1990) and New (1992). The more recent work appears to have particularly stated the different perspectives. For example, Hill *et al.*'s (1998) study of strategic realignment in a pharmaceutical company suggested that improving marketing-manufacturing fit through changes such as increased batch sizes (leading to inventory build-up) helped competitiveness. However, Schonberger (1999) pointed out that such choices were inconsistent with accepted BPs, to which Hill *et al.* (1999) replied they were still appropriate because of the company's market and industry background. Another example is Pilkington's (1998) suggestion that success of Japanese car manufacturers must be attributed to building capabilities and aligning manufacturing to markets, instead of simply adopting lean practices; likewise, Harrison (1998) suggested that manufacturing competitiveness depended more on consideration of strategic needs than on indiscriminate adoption of lean practices.

Voss's (1995) seminal paper encapsulated these alternatives into paradigms, namely "competing through manufacturing" (capabilities), "strategic choice" (fit), and "best practice". He suggested that all three paradigms must be considered in the manufacturing strategy process due to their own merits and limitations.

Despite the continuous research on these paradigms, we do not seem able to resolve that debate yet. In particular, it does not seem clear what paradigm or combination of paradigms can best explain performance improvements. For a start, most empirical studies investigated effects of individual paradigms as independent from others. We know of three studies that explored performance relationships with multiple paradigms: Morita and Flynn (1997), Ketokivi and Schroeder (2004a) and Swink *et al.* (2005). Our study differs from their contributions in two aspects. First, we conceptually distinguish between BPs adoption and capability learning, whereas, Morita and Flynn (1997) and Ketokivi and Schroeder (2004a) viewed them under the common concept of "practices", and Swink *et al.* (2005) assessed capabilities from a manufacturing performance view. Second, following Bozarth and McDermott's (1998) recommendation and a dearth of empirical studies, we develop an objective index of internal fit, whereas the previous studies addressed fit either as differences in practices adoption (Morita and Flynn, 1997), as strategic priority (Ketokivi and Schroeder, 2004a), or by a perceptual measure of "strategy integration" (Swink *et al.*, 2005).

This study explores manufacturing performance relationships with the three paradigms. Specifically, we test whether scales of internal fit, capabilities, and BPs relate to performance improvements in manufacturing. The results suggest that both capabilities and BPs may be positively associated with performance improvements in the sample, whereas internal fit appears to be negatively related with flexibility improvements.

Literature review and hypotheses

There is an old debate in manufacturing strategy regarding the validity of paradigms of choice of operations configuration. Voss (1995, 2005) reviewed three paradigms, namely "strategic choice", "best practice", and "competing through manufacturing". Research on each of the three paradigms is reviewed in the following section.

Fit

For over 30 years, the concept of fit has been at the core of management studies. Venkatraman and Camillus (1984) and Drazin and van de Ven (1985) indicated it originally appeared in contingency theory studies, which assume, "[. . .] that context and structure must somehow fit together if the organization is to perform well" (Drazin and van de Ven, 1985, p. 514).

Conceptualizing fit is not straightforward. In broad terms, fit refers to matching (Venkatraman and Camillus, 1984) or consistency (Doty *et al.*, 1993) among aspects of context and organization. Miller (1992) distinguished between external ("environmental") fit linking environment to structure, and "internal" fit linking structure to processes. Venkatraman (1989) defined six categories of fit corresponding to particular measures and analytical procedures.

Many strategy studies found significant business performance relationships with both external and internal fit (Venkatraman and Prescott, 1990; Powell, 1992; Naman and Slevin, 1993; Yin and Zajac, 2004; Olson *et al.*, 2005). However, Habib and Victor (1991) and Barth (2003) found no definite support to hypotheses that firms with higher strategy-structure fit outperformed firms with lower strategy-structure fit. They both suggested that capabilities such as experience and change ability might lead to financial or business performance benefits that were higher than the benefits achieved by simply adhering to theoretical profiles of strategy and organization.

In manufacturing strategy, several studies found positive links between external fit and performance. Anand and Ward (2004) found that interactions between emphasis on manufacturing flexibility, and environment uncertainty and change positively related to market share and sales growth. Others found that alignment between business and operations strategy was positively associated to operations performance such as quality and inventory (Brown *et al.*, 2007) and business performance such as sales growth and market share (Papke-Shields and Malhotra, 2001) and profit (Smith and Reece, 1999). Additionally, da Silveira (2005) provided evidence of a positive link between an overall measure of internal and external fit based on Hill (2000) and market share. An exception to this pattern is Lindman *et al.* (2001) who did not find a relationship between product-process alignment and manufacturing performance.

From a research perspective, Bozarth and McDermott (1998, p. 437) identified the need for more research addressing internal fit, especially as stronger competitive pressures "[. . .] should make it harder for internally unfocused manufacturing units to survive". They adopted Miller's (1992, p. 163) distinction between external and internal fit, the latter meaning "fit among variables of structure, between structure and process, and among variables of process". As indicated by Bozarth and McDermott (1998; and supported by our review above), most of the existing frameworks have focused on external fit, and only the order-winners framework (Hill, 2000) appeared to consider internal fit together with external fit. Based on their recommendation and the literature above, we put forward the following hypothesis:

H1. Internal fit is positively related to manufacturing performance improvements.

Capabilities

The idea of "competing through capabilities" in manufacturing has been introduced by authors such as Hayes and Pisano (1994) and Hayes and Upton (1998) who suggested that the true objective with manufacturing strategy was to build competencies for sustainable competitive advantage. Hayes and Pisano (1994) in particular were critical of implementing programs such as just-in-time (JIT) or total quality management (TQM) for short-term gains only, and even of relying on "strategic fit" in times of competitive turbulence.

The incorporation of capabilities or competence-based analyses in manufacturing strategy was much needed by the time of Hayes and Pisano's (1994) article. As pointed out by Snow and Hrebiniak (1980), the idea of "distinctive competencies" was introduced in the late 1950s by Selznick (1957), and expanded by Andrews (1971) to denote the activities a firm could do better than competitors. In economics, Wernerfelt (1984) formalized the "resource-based view of the firm" suggesting that a firm's competitiveness could be more easily explained by its resources than by its products. Barney (1991) established further that for resources to provide competitive advantage they must be valuable, difficult to obtain and substitute, and hard to imitate.

In operations strategy, Schroeder *et al.* (2002) developed a model of manufacturing capabilities and performance. They classified manufacturing resources and capabilities in three categories named "internal learning", "external learning", and "proprietary processes and equipment". The model gave strong emphasis to the role of knowledge acquisition, as external and internal learning were antecedents to processes and equipment.

A view on learning as the core capability of the organization had been earlier established by studies on the "knowledge based view" of the firm (Grant and Baden-Fuller, 1995; Nonaka *et al.*, 2000). Under this theory, knowledge is considered a firm's main production input or resource, and it can only be created or acquired by its individuals (Grant and Baden-Fuller, 1995; Turvani, 2001). As emphasised by Schroeder *et al.* (2002) and Muller and Pénin (2006), a firm's knowledge is obtained from either internal sources, mainly labour, or external sources, mainly supply chain relationships. Several studies, e.g. Levin (2000) and Landaeta (2008) provided evidence to positive relationships between learning or knowledge stock and performance. This literature leads to the following hypothesis:

H2. External and internal learning are positively related to manufacturing performance improvements.

Best practices

Research on "best practices" in operations emerged in the 1980s as part of the effort to explain the success of Japanese manufacturing in Western markets (Voss, 1995; Laugen *et al.*, 2005). According to Voss (1995), the concept of BPs has been often associated to "world class manufacturing" (Hayes and Wheelwright, 1984; Schonberger, 1986). The underlying premise is that plants can improve performance by adopting programs that can be identified through benchmarking and learning from other plants (Voss *et al.*, 1997). Examples of BPs include TQM, lean production, new product design/development, and advanced manufacturing technologies (Voss, 1995; Flynn *et al.*, 1999; Narasimhan *et al.*, 2005). Although these practices are usually considered under the aegis of operations management, several have a cross-functional and systemic nature.

Managers work through practices to realize organizational improvements. Relationships between BPs and manufacturing performance have been studied from a number of perspectives. Some authors studied the context dependency of BPs, suggesting that the extent of their performance impact might depend on fit with the organizational context (Sousa and Voss, 2001; Davies and Kochhar, 2002). It has been also suggested that different practices related to different performance aspects (Narasimhan *et al.*, 2005). Others have looked at implementation issues including the sequence of adoption of individual practices, and whether multiple practices are needed to influence performance (Dow *et al.*, 1999; Sousa and Voss, 2002; Narasimhan *et al.*, 2005). Finally, studies have found evidence of combined effects of adopting several BPs (Flynn *et al.*, 1999; Cua *et al.*, 2001; Kaynak, 2003; Shah and Ward, 2003).

Overall, there is overwhelming empirical support – spanning different sets of practices, countries and industries – for links between BPs adoption and improved manufacturing performance (Flynn *et al.*, 1995; Hendricks and Singhal, 1997; Samson and Terziovski, 1999; Cua *et al.*, 2001). Therefore, we put forward the *H3*:

H3. Best practices are positively related to manufacturing performance improvements.

Data

Data were obtained from the fourth round of the International Manufacturing Strategy Survey (IMSS-IV). This global project periodically collects data on manufacturers of metal products, machinery, equipment, and instruments (International Standard Industrial Classification (ISIC) 3.1 codes 28-35). These, and the following information about the survey appeared in previous IMSS-IV studies, e.g. Batley *et al.* (2006) and Vecchi and Brennan (2009).

IMSS-IV was carried out in 23 countries between January 10, 2005 and February 20, 2006. It consisted of a self-administered questionnaire containing both objective and perceptual items on the strategies, practices, and performance of manufacturing units. The target respondent was the company's Director of Operations, Manufacturing, or equivalent. The survey was centrally coordinated to maximize consistency in data collection procedures across countries. Companies and their contact information were initially identified by search in public or private databases in each country. Target companies were called to verify contact information and interest in the questionnaire. Questionnaires were sent out to interested companies, which were often reminded about the survey by additional letters, e-mails, or phone calls. After returning questionnaires, companies might be called once more to check about missing data. Data were input into electronic spreadsheets by individual country offices. The central coordination at Politecnico di Milano (Italy) carried out quality checks and pooled all data together. The final consolidated database was released to the network on January 31, 2007.

This study uses data from 22 of the 23 countries in IMSS-IV, including Argentina, Australia, Belgium, Brazil, Canada, China, Denmark, Estonia, Germany, Hungary, Ireland, Israel, Italy, New Zealand, Norway, Portugal, Sweden, The Netherlands, Turkey, the UK, the USA, and Venezuela. Data from one country were not used due to a low (1 percent) response rate. Altogether, the 22 countries contacted 4,587 companies, sent out 3,051 questionnaires, and received 698 valid responses, representing 15.2 percent of the contacted companies. A total of 12 country offices tested for differences between respondents and non-respondents on demographics such as company size and ISIC; they all obtained non-significant results.

Data were visually inspected for errors and outliers prior to the analysis. One observation had an extreme level of work-in-process inventory ($z = 18.8$). Even though the response appeared valid, its use would bias the fit index (measure development section), so it was excluded from the analysis.

Some of the data used in this research were reported in previous IMSS-IV studies. For example, Batley *et al.* (2006) reported descriptive statistics among New Zealand respondents; Dukovska-Popovska and Boer (2008) tested effects of strategic choices and contingencies on individual performance items such as product customization ability and time to market; Vecchi and Brennan (2009) used process equipment and training investment data to assess innovation intensity.

Measure development

We operationalized fit and capability learning by formative indicators and BPs by reflective indicators. As indicated by Diamantopoulos and Winklhofer (2001) and MacKenzie (2003), formative indicators are causes, whereas reflective indicators are consequences of the latent measure. In the literature, fit and capabilities have often been considered to follow rather than precede changes over respective indicators, e.g. firms maintain fit by "changes in internal systems and structures" (Pant, 1998, p. 288), and capabilities are developed by knowledge integration (Zahra *et al.*, 2005). BPs, on the other hand, are accessed via "external leveraging" (Mathews, 2003, p. 1174), so implementing particular elements, e.g. statistical process control often follows rather than leads the decision to adopt the BP, e.g. TQM.

Fit

Fit was operationalized as formative index based on several conceptual underpinnings. First and following Voss's (1995) framework, the index addressed "internal fit" as defined by Miller (1992). Thus, (and differently from da Silveira, 2005), the index included internal elements of process and infrastructure but no external aspects of market and industry. Second and following Venkatraman (1989), the index was operationalized as "gestalt", assessing "[...] the degree of internal coherence among a set of theoretical attributes" (p. 432). In Venkatraman's (1989) terms, this is equivalent to a "profile deviation" perspective under equifinality, as used in da Silveira (2005). Thus, the index incorporated a set of structural and infrastructural aspects of manufacturing choice. Using this perspective seemed particularly adequate in light of classical frameworks, e.g. Hayes and Wheelwright (1984) and Hill (2000) that viewed fit as alignment among several aspects of process and infrastructure under multiple ideal configurations.

Having defined the scope and aim of the index, we used several guidelines for the choice of fit indicators. First, as Venkatraman (1989) indicated, the choice must be guided by theory rather than data. Hence, we used the Hill (2000) framework as theoretical basis because:

- it is one of the most disseminated models of fit in operations strategy;
- it clearly defines choices along a series of manufacturing structural and infrastructural aspects under equifinality; and
- it appears to explain firm performance (market share), as it was proposed by Hill (2000) and supported by da Silveira (2005).

Second, Diamantopoulos and Winklhofer (2001, p. 271) stressed that "[. . .] the items used as indicators must cover the entire scope of the latent variable as described under the content specification". Thus, indicators represented all of the three internal dimensions of manufacturing, investment, and infrastructure in the Hill (2000) framework, and in approximate proportion to the number of choices in each dimension. Finally, Bozarth and Berry's (1997) review indicated that the set of variables to incorporate in a fit index should meet not only theoretical correspondence, but also requirements of parsimony and measurability. Thus, we used seven indicators, all of which were readily available from the IMSS-IV database. Table I presents the fit indicators and their related aspects in Hill (2000).

Indicators choice and validation. Development of the fit index followed procedures in Diamantopoulos and Winklhofer (2001) and Jarvis *et al.* (2003), and their application in Diamantopoulos and Siguaw (2006). A multiple indicators and multiple cause (MIMIC)

Fit indicator	IMSS-IV question: item	Aspect in Hill (2000, pp. 122-3)	n	min	max	μ	σ
Manufacturing							
MASSPROD	To what extent do you use one of the following process types (percent of total volume): mass production	Production volumes	689	0	100	21.80	33.91
DOMUTIL	Indicate degree of the following action programs undertaken over the last three years (1, none; 5, high): engaging in process automation programs	Dominant utilization	669	1	5	2.68	1.17
Investment and cost							
CAPINV[a, b]	During the last three years, approximately what proportion of business unit sales was invested on: process equipment (percent)	Level of capital investment	550	0	80	7.92	10.45
WIP[a]	How many days of production (on average) do you carry in the following inventories: work-in-process	Work-in-progress	626	0	360	17.40	27.70
GOODSINV	How many days of production (on average) do you carry in the following inventories: finished goods	Finished goods	623	0	360	17.85	32.07
DIRWAGES	Estimate the present cost structure in manufacturing: direct salaries/wages (percent of total costs)	Direct labour	629	0.9	80	21.02	12.99
Infrastructure							
SUPERV	How many employees are under the responsibility of one of your line supervisors (on average): in assembly	Control	533	0.83	600	30.93	57.54

Notes: [a]Variables from IMSS-III also used by da Silveira (2005); [b]dropped in subsequent validation stage

Table I.
Fit indicators

model was built with all formative indicators plus two reflective measures to allow identification (Diamantopoulos and Winklhofer, 2001; Jarvis *et al.*, 2003). All formative indicators had paths leading to a single latent variable (called "high-volume process"). Following Hill (2000), we expected the coefficients of *MASSPROD*, *DOMUTIL*, *CAPINV*, *GOODSINV*, and *SUPERV* to be positive (as they should increase with high-volume production), and the coefficients of *WIP* and *DIRWAGES* to be negative (as they should decrease with high-volume production). The two reflective measures of design/engineered to order (*DETO*) and use of dedicated lines (*DEDLINES*) were used for identification. As with the formative measures, their regression weights were expected to be significant and with opposite signs as in theory high volume production correlates negatively with *DETO* and positively with dedicated lines (Hill, 2000).

Validation started by assessing multicollinearity among indicators (Diamantopoulos and Winklhofer, 2001). This did not seem problematic as variance inflation factors (VIFs) were below ten and condition indices (CIs) were below 30 (Kennedy, 2003). The second step consisted in estimating fit and path estimates for the model (Diamantopoulos and Winklhofer, 2001). *CAPINV* had a non-significant regression weight ($p > 0.10$) and was dropped without disadvantage to content validity as it was one of four investment indicators. The model with six indicators had satisfactory fit ($\chi^2/\text{df} = 2.046$; TLI = 0.858; CFI = 0.980; RMSEA = 0.039; CI = 0.000-0.073; PCLOSE = 0.660) except for TLI being somewhat below recommendations. All six indicators loaded on the latent variable with the expected (positive or negative) sign. A total of five indicators had significant ($p < 0.05$) standardized regression weights while *SUPERV* had a near-significant ($p = 0.070$) weight.

Calculation of the fit index. Following validation, the six remaining indicators were converted to 0-1 scale to facilitate calculation of the index. In Hill (2000), choices represented by *MASSPROD*, *DOMUTIL, GOODSINV*, and *SUPERV* relate positively, and choices represented by *WIP* and *DIRWAGES* relate negatively with process volume. Thus, the first four indicators were transformed to 0.1 scale by:

$$x_i^{'} = \left[\frac{(x_i - \min_x)}{(\max_x - \min_x)}\right]$$

where $\min_x$ and $\max_x$ are the minimum and maximum observed values of indicator x in the sample. In reverse, *WIP* and *DIRWAGES* were transformed by:

$$x_i^{'} = 1 - \left[\frac{(x_i - \min_x)}{(\max_x - \min_x)}\right]$$

Following the rationale in Dess (1987), which was adopted by Lindman *et al.* (2001) and da Silveira (2005), we calculated the index by taking the standard deviation among the six transformed indicators and subtracting from one (da Silveira (2005) for how this operationalization is equivalent to Euclidean distance under equifinality). Thus, high *FIT* represented high "internal coherence" (Venkatraman, 1989, p. 432) among indicators.

Capability learning

The choice of capability learning indicators was based on Schroeder *et al.* (2002). They explored manufacturing performance relationships with three capability sources, namely "internal learning", "external learning", and "processes and equipment". They validated a model placing the first two constructs as antecedents of the third, which in turn related to performance. Thus, we built indices corresponding to the two independent capability sources of internal learning and external learning. The indicators and their correspondence to scales in Schroeder *et al.* (2002) are discussed in the following section.

Index formation. Building the external and internal learning indices also followed procedures in Diamantopoulos and Winklhofer (2001), Jarvis *et al.* (2003), and Diamantopoulos and Siguaw (2006). Table II presents the indicators and their relationship to items in Schroeder *et al.* (2002).

The external learning model included six formative and two reflective measures. Formative measures assessed supplier and customer involvement in product development (*SUPDESIGN*, *CUSTDESIGN*), sharing of planning and forecasting knowledge with suppliers and customers (*SUPKNOW*, *CUSTKNOW*), and collaborative planning, forecasting and replenishment with suppliers and customers (*SUPCOLLAB*, *CUSTCOLLAB*). Reflective measures assessed coordination of decisions and flows with suppliers (*SUPCOORD*) and customers (*CUSTCOORD*). All of the measures should correlate positively with the latent variable.

All VIFs and CIs were below the maximum recommended levels (Kennedy, 2003). The model had satisfactory fit (χ^2/df = 3.189; NFI = 0.984; TLI = 0.919; CFI = 0.989; RMSEA = 0.056; CI = 0.027-0.088; PCLOSE = 0.324). All indicators except *CUSTDESIGN* had significant ($p < 0.05$) regression weights. Thus, the *EXTLEARN* index was calculated by taking the average of the five indicators of *SUPDESIGN*, *SUPKNOW*, *SUPCOLLAB*, *CUSTKNOW*, and *CUSTCOLLAB*. The refined model had good fit (χ^2/df = 3.598; NFI = 0.985; TLI = 0.921; CFI = 0.989; RMSEA = 0.061; CI = 0.029-0.097; PCLOSE = 0.249).

The internal learning MIMIC model had five formative and two reflective measures. The formative measures related to labour suggestions (*SUGGESTIONS*), multi-task training (*TRAINING*, *ROTATION*), and task flexibility (*AUTONOMY*, *DELEGATION*). The reflective measures considered the proportion of labour working in cross-functional teams (*TEAMS*) and annual hours of training per employee (*HOURS*). As with the external learning model, all of the measures were expected to correlate positively with the latent variable.

The complete model had good fit (χ^2/df = 1.769; NFI = 0.979; TLI = 0.932; CFI = 0.990; RMSEA = 0.033; CI = 0.000-0.073; PCLOSE = 0.711), CIs below 30, and VIFs below ten (Kennedy, 2003). However, *AUTONOMY* was dropped due to a non-significant regression weight ($p = 0.204$). This did not affect content validity as *AUTONOMY* was one of two indicators of Schroeder *et al.*'s (2002) task flexibility item.

The model with four indicators had good fit except for TLI (χ^2/df = 2.347; NFI = 0.955; TLI = 0.793; CFI = 0.970; RMSEA = 0.044; CI = 0.000-0.087; PCLOSE = 0.519), and all regression weights were highly significant ($p < 0.01$). *INTLEARN* was calculated by the average of the four remaining indicators.

Best practices

We focused on the three main practices discussed by Voss (1995) under the BP paradigm: TQM, lean production, and new product development (concurrent engineering). These receive most attention in practice-performance research and encompass most of the so-called "world class manufacturing" practices (Hayes and Wheelwright, 1984;

Indicator	IMSS-IV item	Item in Schroeder *et al.* (2002, p. 117)	n	μ[a]	σ
External learning (EXTLEARN)					
SUPDESIGN	Supplier collaboration in product development process	"We maintain close communication with suppliers about quality considerations and design changes".	669	2.92	1.11
CUSTDESIGN[b]	Customer collaboration in product development process	"Our customers are actively involved in the product design process".	668	3.46	1.10
SUPKNOW	Production planning and forecasting knowledge sharing with suppliers	"We strive to establish long-term relationships with suppliers".	668	3.38	1.15
SUPCOLLAB	Collaborative planning, forecasting, and replenishment with suppliers		660	2.76	1.11
CUSTKNOW	Production planning and forecasting knowledge sharing with customers	"Our customers give us feedback on quality and delivery performance".	655	3.20	1.25
CUSTCOLLAB	Collaborative planning, forecasting, and replenishment with customers		647	2.75	1.26
Internal learning (INTLEARN)					
SUGGESTIONS	Employee suggestions on product and process improvement (five-item scale of employee suggestions per year)	"Management takes all product and process improvement suggestions seriously" ".Many useful suggestions are implemented at this plant".	681	2.70	0.98
TRAINING[c]	Revenue percent invested on training and education (converted to one to five scale)	"Employees receive training to perform multiple tasks".	531	1.26	0.43
ROTATION	Frequency of workers rotation between jobs or tasks		674	3.16	1.01
AUTONOMY[b]	Workforce autonomy in performing tasks	"Employees are cross-trained at this plant so that they can fill for others if necessary".	679	3.05	0.94
DELEGATION	Actions to increase delegation and knowledge of workers (e.g. training, autonomous teams, etc.)		673	2.89	0.98

Notes: [a]All indicators assessed on five-point scale; [b]dropped in subsequent validation stage; [c]converted to 1-5 scale by $[(x_i/10) + 1]$, $x = [0, 40]$

Table II.
Internal and external learning indicators

Flynn *et al.*, 1999). Presently, these are considered mature, and thus their performance effects can be more reliably studied (Sousa and Voss, 2008).

The rationale for scale construction was to select IMSS-IV items covering the construct domain of each set of BPs (Table III). In all items, respondents were asked to indicate the degree of use of action programs over the previous three years.

TQM comprises three main principles: continuous improvement, customer focus and system view of the organization (Dean and Bowen, 1994; Sitkin *et al.*, 1994).

Scale/item	IMSS-IV item	Construct domain dimensions and supporting studies	n	μ^{a}	σ
Total quality management (TQM)					
QIMP	Undertaking programs for quality improvement and control (e.g. TQM programs, Six Sigma projects, quality circles, etc.)	Continuous improvement principle of quality management (Dean and Bowen, 1994; Sitkin *et al.*, 1994)	656	3.10	1.08
EQUIPIMP	Undertaking programs for the improvement of your equipment productivity (e.g. total productive maintenance programs)	TPM as supplement to quality management approaches (Miyake and Enkawa, 1999)	671	2.85	1.11
ENVIMP	Undertaking programs to improve environmental performance of processes and products (e.g. environmental management system, life-cycle analysis, design for environment, environmental certification)	Broader perspective in quality management to incorporate environmental waste (Corbett and Klassen, 2006)	660	2.72	1.20
Lean production (LEAN)					
PROCFOCUS	Restructuring manufacturing processes and layout to obtain process focus and streamlining (e.g. reorganize plant-within-a-plant; cellular layout, etc.)	Utilization of manufacturing cells (Swink *et al.*, 2005)	670	3.31	1.15
PULLPROD	Undertaking actions to implement pull production (e.g. reducing batches, setup time, using kanban systems, etc.)	Pull or kanban-based production systems, lot size reduction (Swink *et al.*, 2005)	659	2.90	1.19
New product development (NPD)					
STANDARD	Increasing performance of product development and manufacturing through, e.g. platform design, standardization and modularisation	Product design simplicity (Flynn and Flynn, 2004)	663	2.92	1.04
ORGINT	Increasing the organizational integration between product development and manufacturing through, e.g. quality function deployment, design for manufacturing, design for assembly, teamwork, job rotation and co-location, etc.	Interfunctional design efforts (Flynn and Flynn, 2004)	661	2.83	1.03
TECHNOINT	Increasing the technological integration between product development and manufacturing through, e.g. CAD-CAM	CAD use for cross-functional information sharing (Tan and Vonderembse, 2006)	653	3.03	1.13

Note: [a]All items assessed on five-point scale with degree of use endpoints 1 = none and 5 = high

Table III.
BP items

For parsimony, this scale focused on practices of continuous improvement, which are expected to have a particularly significant impact on operational performance. It comprised the three items in the survey assessing the use of quality-related improvement programs: quality in general (*QIMP*), equipment productivity (*EQUIPIMP*) and the environmental performance of processes and products (*ENVIMP*).

Lean production encompasses a wide set of practices, including some related to quality management (Shah and Ward, 2003). Thus, we focused on a set of practices which are distinctive of the lean approach, namely JIT flow (Swink *et al.*, 2005). These practices have the primary goal of eliminating waste in material movement, work-in-process, and delays (Sugimori *et al.*, 1977). Accordingly, the *LEAN* scale was based on the domain of Swink *et al.*'s (2005) "JIT Flow" construct. It comprised two items assessing the use of focused processes (*PROCFOCUS*) and pull production (*PULLPROD*).

The construct domain for new product development (NPD) varies somewhat across existing instruments (Flynn and Flynn, 2004; Tan, 2001; Koufteros *et al.*, 2002; Swink *et al.*, 2005). This scale was based on the two dimensions covered by Flynn and Flynn (2004; product design simplicity and interfunctional design efforts), complemented by "CAD use for cross-functional information sharing" in Tan and Vonderembse (2006). Thus, it comprised three items assessing standardization/simplification (*STANDARD*), organizational integration (*ORGINT*), and technological integration (*TECHNOINT*) practices.

Manufacturing performance

There is general consensus that cost, quality, delivery, and flexibility constitute the four main dimensions of manufacturing (or operational) performance (Schmenner and Swink, 1998; Ward *et al.*, 1998; Schroeder *et al.*, 2002). In our study, we adapted the well-known scales by Ward *et al.* (1998) to measure these four dimensions. Their scales were validated in a sample with an industry sector composition with a significantly overlap with that of IMSS-IV. The IMSS-IV database includes items that closely match this scale. Table IV presents the performance items from IMSS-IV with their correspondence to the dimensions in Ward *et al.* (1998). Respondents were asked, "How has your operational performance changed over the last three years?" Responses were given in a five-point Likert scale with endpoints one (deteriorated more than 10 percent) and 5 (improved more than 50 percent).

Measurement model

We used confirmatory factor analysis (CFA) to check unidimensionality, validity, and reliability of scales. The model was tested in Amos™ 17.0 (Arbuckle, 2008) using maximum likelihood estimates. The measurement model included the ten dependent and independent variables. Assuming that the formative variables of *FIT*, *EXTLEARN*, and *INTLEARN* were perfectly determined by their (single) indices, we set variances of their error components to zero (Brown, 2006, p. 139).

Fornell and Larcker (1981) suggested that convergent validity could be established for scales having average variance extracted (AVE) above 0.5. However, initial AVEs were 0.40 (*COST*), 0.46 (*QUALITY*), 0.43 (*FLEXIBILITY*), 0.52 (*DELIVERY*), 0.49 (*TQM*), 0.49 (*NPD*), and 0.48 (*LEAN*). Also, pairwise correlations among performance

Scale/item	IMSS-IV item	Item in Ward *et al.* (1998, p. 1039)	n	μ[a]	σ
COST[b]					
OVHCOST	Overhead costs	*Production cost*	667	2.53	0.83
UNTCOST	Unit manufacturing cost	*Cost*	672	2.74	0.84
LBPROD	Labor productivity	*Labor productivity* *Productivity*	673	2.94	0.80
INVTNR	Inventory turnover	*Reducing inventory*	669	2.74	0.84
CAPUTL	Capacity utilization	*Capacity utilization*	673	2.83	0.90
QUALITY					
PRDQUAL	Product quality and reliability	*High-product performance* *High-product durability* *High-product reliability*	679	3.06	0.85
CONF	Manufacturing conformance	*Conformance to design specs*	674	2.98	0.84
CUSTSRV[b]	Customer service and support	*Ease to service product* *Promptness in solving customer complaints*	672	2.92	0.88
DELIVERY					
DELDEP	Delivery dependability	*Delivery on due date* *On-time delivery*	672	3.02	0.95
MFCTLT	Manufacturing lead time	*Reduce production lead time*	672	2.80	0.87
PROCLT	Procurement lead time	*Production cycle time*	673	2.58	0.83
DELSPD	Delivery speed	*Short delivery time*	674	2.98	0.93
FLEXIBILITY					
MIXFLEX	Mix flexibility	*Large number of product features or options*	667	2.97	0.88
PRDCUST[b]	Product customization ability	*Design changes in production*	667	2.87	0.86
TTM[b]	Time to market	*New products into production quickly*	666	2.83	0.89
VOLFLEX	Volume flexibility	*Rapid capacity adjustment*	673	3.12	0.88

Notes: [a]All items assessed on five-point scale; [b]dropped in subsequent validation stage

Table IV. Manufacturing performance items

variables were higher than the squared root of their AVEs, which indicates a lack of discriminant validity (Fornell and Larcker, 1981). Given those results, we refined the model by dropping the *COST* and *LEAN* scales, and by deleting two items from *FLEXIBILITY* and one item from *QUALITY*.

Table V presents statistics for the refined model. Unidimensionality was supported by good fit estimates (χ^2/df = 2.379; NFI = 0.936; TLI = 0.937; CFI = 0.961; RMSEA = 0.045; CI = 0.037-0.052; PCLOSE = 0.881; Kumar and Dillon, 1987; Steenkamp and van Trijp, 1991). Standardized regression weights were all significant ($p < 0.001$) and had critical ratios above 2.0, suggesting convergent validity (Anderson and Gerbing, 1988). AVEs were all close to or above 0.5, which also supports convergent validity (Fornell and Larcker, 1981). AVE square roots were greater than pairwise correlations, suggesting discriminant validity (Fornell and Larcker, 1981). CR estimates were above 0.6 (Bagozzi and Yi, 1988).

We further tested for discriminant validity by comparing fit (χ^2) between constrained and unconstrained pairwise models (Anderson and Gerbing, 1988; except for pairs of formative indices). Unconstrained models were obtained by setting all paths

Table V. Measurement scales

	Standard regression Weights	CR	AVE	Pairwise correlations 1	2	3	4	5	6	7
1. *DELIVERY* (2.84[a], 0.72[b], 658[c])		0.81	0.52	*(0.72)*						
DELSPD	0.80									
DELDEP	0.74									
MFCTLT	0.69									
PROCLT	0.65									
2. *FLEXIBILITY* (3.04[a], 0.79[b], 664[c])		0.74	0.58	0.66	*(0.76)*					
VOLFLEX	0.81									
MIXFLEX	0.72									
3. *QUALITY* (3.02[a], 0.75[b], 673[c])		0.73	0.57	0.66	0.57	*(0.76)*				
CONF	0.79									
PRDQUAL	0.73									
4. *TQM* (2.89[a], 0.92[b], 636[c])		0.74	0.49	0.37	0.29	0.36	*(0.70)*			
QIMP	0.68									
EQUIPIMP	0.77									
ENVIMP	0.66									
5. *NPD* (2.93[a], 0.87[b], 651[c])		0.74	0.49	0.35	0.26	0.27	0.67	*(0.70)*		
STANDARD	0.73									
ORGINT	0.77									
TECHNOINT	0.59									
6. *FIT* (0.58[a], 0.04[b], 435[c])		–	–	−0.06	−0.18	−0.07	−0.03	−0.04		
FIT	1.00									
7. *EXTLEARN* (3.00[a], 0.77[b], 608[c])		–	–	0.28	0.27	0.23	0.46	0.43	−0.11	
EXTLEARN	1.00									
8. *INTLEARN* (2.49[a], 0.50[b], 504[c])		–	–	0.23	0.17	0.18	0.45	0.42	−0.01	0.32
INTLEARN	1.00									

Notes: AVE square roots are in italics and parentheses on main diagonal; [a]means, [b]standard deviations, and [c]valid n obtained with PASW® 17.0 (SPSS, 2009); standard regression weights and pairwise correlations obtained with Amos™ 17.0 (Arbuckle, 2008) with maximum likelihood estimates ($n = 697$)

from latent to observed variables free, all latent variable variances to one, and the covariance between the pair of latent variables free (Brown, 2006; ZenCaroline, 2008). Constrained models had this covariance set to one. All χ^2 differences (1 df) between constrained and unconstrained models exceeded the upper critical value of 10.838 ($p < 0.001$), which further supported discriminant validity.

Common method bias

Variables were obtained from single respondents, which might lead to biases due to "social desirability" or "illusory correlations", etc. (Podsakoff and Organ, 1986; Podsakoff *et al.*, 2003). To minimize such biases, the survey incorporated practices in Podsakoff *et al.* (2003), i.e. guaranteed anonymity and confidentiality, and questions/items described clearly and concisely.

We assessed the potential common method bias (CMB) in our data with Harman's single-component test (Podsakoff *et al.*, 2003) by testing a model where a single latent variable related to the 17 observed variables. The model had poor fit (χ^2/df = 11.744; NFI = 0.602; TLI = 0.511; CFI = 0.619; RMSEA = 0.124; CI = 0.118-0.130; PCLOSE = 0.000), suggesting that CMB was not a problem.

Control variables

We introduced control variables that previous studies suggested might explain performance improvements. Size may have either positive or negative correlations with performance. For example, studies found that smaller firms had lower external failure costs as percentage of revenue (Rodchua, 2009) and that they were more able to profit with production flexibility than larger firms (Fiegenbaum and Karnani, 1991); however, larger firms in capital intensive sectors might still have greater sales volume flexibility (Jack and Raturi, 2003). Company size (*SIZE,* $\mu = 602.51$, $\sigma = 1620.39$, $n = 692$) was measured by the number of employees in the business unit. Studies also suggested that manufacturers in some developing countries might be achieving rapid performance improvements (Kim, 1998; Zhao *et al.*, 2006). Country development was measured by GDP per capita (*GDPCAP,* $\mu = 26962.68$, $\sigma = 16561.17$, $n = 697$) using 2005 US Dollar estimates from WDI Online (World Bank, 2009). Finally, market growth might lead to increased competitiveness, driving improvements in quality, delivery, and cost (Landsom, 2000). Market dynamics (*MKTDYN,* $\mu = 3.41$, $\sigma = 0.80$, $n = 691$) was measured by the survey item on extent of market growth: "How would you describe the external environment: market dynamics", using a five-point Likert scale with endpoints one (declining rapidly) and five (growing rapidly).

Results

We tested hypotheses via regression analyses. Since regression models used listwise deletion of cases with missing data, we first carried out Little's (1988) test on the eleven dependent, independent, and control variables to check if data could be considered as missing completely at random (MCAR). Listwise deletion of cases with missing data is considered acceptable under MCAR (Chen and Åstebro, 2003; Fichman and Cummings, 2003). The result was non-significant ($p > 0.10$), so data could be considered as MCAR.

We regressed control and independent variables on the three performance variables. The first step included the control variables of *SIZE* (LN-transformed, as in Elango (2006) to improve normality), *GDPCAP*, and *MKTDYN*. In the second step, the independent variables were entered in separate to avoid multicollinearity effects. Hypotheses were tested based on the significance of regression coefficients and *F*-change statistics. VIFs were well below ten, suggesting that multicollinearity was not a problem (Kennedy, 2003). One CI in models having *FIT* as predictor was above 30, however running the same models with a standardized *FIT* scale yielded a lower index (CI = 14) and similar beta estimates. Histograms and P-P plots suggested that residuals were normally distributed. Table VI presents the results.

The results supported *H2* and *H3*, but not *H1*. *H1* was rejected as *FIT* had no significant coefficients in the *DELIVERY* and *QUALITY* models, and a negative coefficient in the *FLEXIBILITY* model. *H2* was supported due to positive relationships between *EXTLEARN* and the three performance variables, and between *INTLEARN* and both *DELIVERY* and *QUALITY*. *H3* was also supported because of significant *TQM* coefficients in the three models, and significant and near-significant relationships between *NPD* and, respectively, *DELIVERY* and *QUALITY*. Regarding control variables, *GDPCAP* had negative relationships with *QUALITY* and *DELIVERY*, whereas *MKTDYN* explained positively all performance outcomes.

Moderation tests[1]

The results with capability learning and BPs broadly conformed to the study hypotheses and to Voss's (1995) model. However, the lack of positive relationships with *FIT* was somewhat surprising. As discussed earlier, many (albeit not all) previous studies found evidence to positive relationships between fit and operations or business performance, even though most of those studies focused on external rather than internal fit. Given those findings, and based on the work of Ketokivi and Schroeder (2004a) and Swink *et al.* (2005), we set out to explore the hypothesis that internal fit might instead have a positive moderating role in performance relationships with capabilities and BPs. Swink *et al.* (2005) in particular found partial evidence that "strategic integration" moderated relationships between BPs, and cost and flexibility. Earlier, Voss (1995) had indicated that paradigms might be associated in practice, which also suggests moderating effects.

To test for moderation, and following Cohen and Cohen (1983) and Aiken and West (1991), we built hierarchical regression models with the three control variables in step 1, predictors relating to a pair of paradigms (i.e. entering together variables of fit and BPs, fit and capabilities, or BPs and capabilities) in step 2, and their interactions in step 3. For example, the model testing for moderations between fit and BPs was specified as:

$$Y = \alpha + \beta_1 LN(SIZE) + \beta_2 GDPCAP + \beta_3 MKTDYN + \beta_4 FIT + \beta_5 TQM + \beta_6 NPD + \beta_7 (FIT \times TQM) + \beta_8 (FIT \times NPD) + \varepsilon$$

where Y is the performance variable (*QUALITY*, *FLEXIBILITY*, or *DELIVERY*). Further, due to potential "bundling" effects of BPs and capabilities, we also tested for their own interactions such as (for BPs):

$$Y = \alpha + \beta_1 LN(SIZE) + \beta_2 GDPCAP + \beta_3 MKTDYN + \beta_4 TQM + \beta_5 NPD + \beta_6 (TQM \times NPD) + \varepsilon$$

In models including capabilities and BPs, we tested for interactions of BPs as predictors and capabilities as moderators, following on the rationale in Cohen and

Table VI. Regression analyses on manufacturing performance improvements

Variable	QUALITY			FLEXIBILITY			DELIVERY		
LN (SIZE)	−0.014	−0.005	0.002	0.075	0.065	0.064	0.048	0.022	0.020
GDPCAP	−0.239***	−0.246***	−0.237***	−0.041	−0.069	−0.098*	−0.117*	−0.164***	−0.140***
MKTDYN	0.118*	0.150**	0.100*	0.163***	0.182***	0.150***	0.171***	0.119*	0.142***
F-change	11.085***	14.458***	14.737***	5.411**	7.138***	8.599***	7.051***	6.943***	8.903***
R^2	0.073	0.089	0.071	0.038	0.047	0.043	0.049	0.045	0.045
Adjusted R^2	0.066	0.083	0.066	0.031	0.040	0.038	0.042	0.039	0.040
LN (SIZE)	−0.018	−0.039	−0.094*	0.065	0.029	−0.015	0.045	−0.022	−0.096*
GDPCAP	−0.239***	−0.247***	−0.199***	−0.040	−0.072	−0.072****	−0.117*	−0.162***	−0.099*
MKTDYN	0.117*	0.117*	0.098*	0.162***	0.153**	0.149***	0.170***	0.073	0.138***
FIT	−0.050			−0.151*			−0.041		
EXTLEARN		0.165***			0.157**			0.209***	
INTLEARN		0.096*			0.069			0.136**	
TQM			0.225***			0.169***			0.236***
NPD			0.084****			0.076			0.131**
F-change	1.138	11.310***	22.046***	9.937*	8.142***	12.481***	0.735	19.045***	29.237***
R^2	0.076	0.134	0.136	0.060	0.081	0.083	0.051	0.122	0.133
Adjusted R^2	0.067	0.124	0.129	0.051	0.071	0.075	0.041	0.112	0.126
n	426	447	585	419	441	580	416	441	577

Notes: Significance at: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, $^{****}p < 0.10$; standardized coefficients are shown; regression analyses in PASW® 17.0 (SPSS, 2009)

Levinthal (1990). Following Jaccard *et al.* (1990), predictors were mean-centered before calculating interaction terms to avoid multicollinearity. Since we estimated 30 beta coefficients and in *post hoc* fashion, we found essential in this case to apply the Bonferroni correction. As explained by Mendenhall and Sincich (1996), the Bonferroni correction controls Type I errors by reducing the critical significance level α to α/t where t is the number of tests carried out. Thus, our *post hoc* coefficients could be considered significant if $p < 0.05/30$ and near significant if $p < 0.10/30$. No interaction term had estimates at this level, although four terms had betas at non-adjusted ($p = 0.05$) levels, and one had an estimate at the $p < 0.10$ level. Thus, on one hand our results did not provide reliable conclusions regarding moderation. On the other, having results at $p < 0.05$ (although they could be attributed to Type I error) recommends more research such as done by Ketokivi and Schroeder (2004a) and Swink *et al.* (2005), among others to explore moderating performance effects among paradigms.

Discussion

Collectively, the results suggest that building capabilities and adopting BPs both have positive relationships with operations performance, whereas internal fit may have even negative relationships with performance. Therefore, developing manufacturing capabilities and adopting BPs seem to be at the core of producing manufacturing performance.

Concerning capabilities, the results stress the importance of external learning, which related to all performance dimensions. Concerning BPs, the results support the notion that different practices may relate to different performance dimensions (Narasimhan *et al.*, 2005). In particular, NPD explained mostly delivery performance, while TQM related to all dimensions.

Results on internal fit

The absence of significant quality and delivery relationships with internal fit is surprising, given the strong emphasis given to fit in the literature. Several explanations may account for this. First, although past studies found evidence of the impact of external fit or aggregated fit (internal and external) on performance, few addressed the impact of internal fit alone (Bozarth and McDermott, 1998). In fact, Miller (1992) even described some potential trade-offs between external and internal fit. Thus, one possible explanation might be that internal fit *per se* cannot explain quality or delivery performance, or that it would only in companies under harsh competitive environments (Bozarth and McDermott, 1998). For example, having a production system with high internal consistency (e.g. high focus of the manufacturing function on process automation and the adoption of a high volume process and infrastructure) may not contribute to performance if the system is not aligned with markets and the external environment (e.g. the high-volume process could be called upon to respond to demands from low-volume markets). This explanation is consistent with studies in the strategy field which emphasise external fit, and would suggest that the same emphasis be applied in manufacturing strategy frameworks. This would also imply considering fit at the broader business unit/firm level, rather than at the narrower plant level (Bozarth and McDermott, 1998).

A second explanation is that there could be a non-linear effect of internal fit on those performance dimensions. It could be that very low levels of internal fit influence performance, but once a minimum threshold is achieved, no further gains are obtained. Hence, internal fit could be seen as a hygiene factor rather than as a key driver of performance. As a third explanation, our results could be seen to support views that fit (either internal or external) does not support improved performance. In the strategy field, a few studies have raised doubts as to the impact of fit on performance (Habib and Victor, 1991; Barth, 2003). In manufacturing strategy, Hayes and Pisano (1994) were critical of relying on "strategic fit" in times of competitive turbulence, while supporters of the BPs paradigm (Schonberger, 1999) argued that a plant exhibiting high coherence between manufacturing choices but employing obsolete practices would most likely not be a good performer. Finally, from an empirical perspective the lack of correlations between fit and quality and delivery performance could be attributed to the measurement of fit, since our index estimated the absolute level of fit at the time of data collection rather than changes in fit levels over a three-year period.

Of particular greater interest, the analysis suggested even a negative relationship between internal fit and flexibility. Again, this would appear to contradict previous operations strategy studies; however, it does align with Schonberger's (1999) view that poor practices cannot be justified under the pretext of maintaining fit (while he particularly emphasised manufacturing flexibility as one possible casualty). For example, manufacturers having high levels of fit as measured by our index would have either high work-in-process or high finished goods inventories in their plants (trade-off view). These practices might appear consistent with other choices in process structure and infrastructure, but for Ohno (1988) either type of inventories still amounts to waste. With flexibility in particular, the organization's cost or effort to maintain internal fit might even limit the options regarding the mix and volume of outputs, especially in changing markets. In such circumstances, internal fit ceases to be an asset and becomes a competitive liability.

Interaction effects and co-variants

We found some limited *post hoc* evidence for moderating effects between paradigms. Previous research raised the possibility of such interaction effects (Voss, 1995), including synergies between capabilities and BPs (Cohen and Levinthal, 1990). For example, the development of organizational capabilities would allow a firm to know why, how, and when to execute a certain practice (Ketokivi and Schroeder, 2004a), while using BPs might contribute to further learning and developing capabilities (Hayes and Pisano, 1996). Similarly, there could be interactions between fit and both BPs and capabilities (Sousa and Voss, 2001; Ketokivi and Schroeder, 2004b). For example, Hayes and Upton (1998) suggested that operations competitiveness relied on both capability development and positioning, while Swink *et al.* (2005) suggested that "strategic integration" could moderate relationships between BPs and performance. The results of our moderating tests do not lend clear support for these views. However, they do encourage further research on paradigm interactions.

Regarding associations between performance and co-variants, the lack of significant relationships with company size was somewhat surprising given the abundant research specifying specific correlations between size and operations performance metrics. Previous studies (Fiegenbaum and Karnani, 1991; Jack and Raturi, 2003; Rodchua, 2009) suggested performance in areas such as quality and flexibility might either increase or decrease with company size, so perhaps building performance variables that included multiple performance items under each scale might have "balanced out" positive and negative correlations with size under the same construct, yielding non-significant relationships. Relationships involving country and market dynamics appeared consistent with expectations and the literature. Countries with lower GDP per capita had greater quality and delivery improvements, which is consistent with views in Kim (1998) and Zhao *et al.* (2006) about countries such as China and India. Finally, companies operating in markets with faster growth registered greater performance improvements, which according to Landsom (2000) might be due to shielding against competition in increasingly more attractive markets.

Conclusions

This study was set out to explore manufacturing performance relationships with Voss's (1995) three paradigms of manufacturing strategy: fit, capability building, and BPs. The results suggest that manufacturing strategy may rely on a binary model of paradigms having capability learning and BP adoption as predictors of performance. On the other hand, maintaining internal fit among variables of process structure and infrastructure may have non-significant or even negative relationships with performance. This study motivates future work aimed at a deeper understanding of fit and its interactions with the other paradigms.

For practitioners, the study suggests that firms should build performance advantage by learning new capabilities and adopting BPs. Concerning capabilities, the impact of external learning on all performance dimensions stresses the need for plants to collaborate and share information with customers and suppliers in such areas as product design and production planning/forecasting. Thus, plants should recognize their network of relationships not only as immediate sources of business, but also as effective sources of learning. Internal learning achieved through a collaborative and empowered workforce should also have a positive impact particularly on quality and delivery. Concerning BPs, the broad performance impact of TQM (whereas, NPD practices seem to have a more focused effect on delivery) reinforces the generally established role of this practice as a driver of overall manufacturing performance (Sousa and Voss, 2002).

We found no evidence of a positive impact of internal fit on performance. This has important implications for practice because today's pace of technology change and shorter life cycles leads to a larger number of manufacturing units in transitional states where poor internal fit may occur (Bozarth and McDermott, 1998). In these fast changing environments, situations of misfit may take time to correct because the associated variables may have high inertia, i.e. be difficult to change in the short-term. Our results suggest that substantial efforts to maintain high levels of internal consistency among manufacturing strategy choices may not always payoff, and might even have detrimental consequences to manufacturing flexibility.

The study has some limitations that provide opportunities for future research. Most data were obtained from a general manufacturing strategy dataset which might in some cases limit the correspondence between constructs and observed variables. The cross-sectional nature of the data did not allow for establishing causality but just correlation between predictors and outcome variables. In particular, fit and capability items refer to levels at the time of fieldwork, whereas hypotheses of causality might ask to investigate fit and capability levels over a period and subsequent performance improvements. Moreover, since data were collected exclusively from manufacturers of metal products, machinery, and equipment, caution should be exercised in generalizing the results to other sectors of the economy. Finally, the results did not help us to explain the role of fit, if any, in improving operations performance with or without building capabilities and adopting BPs. We strongly encourage further studies to overcome these limitations. For example, researchers might explore alternative configurations of fit to explain manufacturing performance, for example by using different sets of indicators, attributing different weights to fit indicators, employing measures of internal and external fit, or examining potential non-linear effects of fit.

Finally, the results must be considered in light of the scales measurement and validation. As explained earlier, for theoretical reasons we built scales of fit and capabilities using formative rather than reflective approaches. As indicated by Collier and Bienstock (2009), building reflective and formative scales involves different specification and validation procedures, and thus the choice of one or another approach might influence the study results.

We are confident that this study significantly contributes to the ongoing debate of paradigms of choice in manufacturing strategy and helps to move the field forward. We hope that our results will foster more research to understand the roles of paradigms and their interactions.

Note

1. We thank the two anonymous reviewers for comments that led to the Moderation tests section.

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