

Manufacturing strategy in context: environment, competitive strategy and manufacturing strategy

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Received 1 July 1997; accepted 1 March 1999

Abstract

Considering manufacturing strategy in its larger strategic context has been thematic in conceptual literature in operations but relatively neglected in empirical studies, thus leaving predominant conceptual models of manufacturing strategy largely untested. This research develops a conceptual model of manufacturing strategy from the literature and tests the model using data from a sample of manufacturers in three industries in the United States. This research contributes to manufacturing strategy literature in four ways. First, it supports empirically a model of manufacturing strategy that is predominant in the conceptual literature. Second, it demonstrates that the strategic linkages in manufacturing businesses are clearer among good performers than poor performers. Third, this research suggests that competitive strategy acts as a mediator between an organization's environment and its manufacturing strategy. Fourth, the findings suggest that the relationship between competitive strategy and performance is mediated by manufacturing strategy. These last two findings have important implications for approaching research in manufacturing strategy in the future. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Operations strategy; Empirical research

1. Introduction

Research in operations management has been characterized in recent years by an increasing effort devoted to the study of manufacturing strategy using empirical methods. A review of the literature reveals that much of this empirical research effort has fo-

cused on the internal consistency of manufacturing strategy (e.g., priorities and programs) and assessing the performance consequences of such consistency. Surprisingly little empirical research has addressed the alignment among manufacturing strategy, business-level competitive strategy, and the competitive environment faced by the firm, although much of the conceptual literature in manufacturing strategy has focused on this issue of alignment (Swink and Way, 1995). Thus the predominant conceptual model of manufacturing strategy that considers manufacturing

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in the larger strategic context of the firm has remained largely unsubstantiated because it has not been adequately tested.

We approach this relatively neglected area by testing empirically an accepted conceptual model of manufacturing strategy in the context of a sample of firms' competitive strategies and environments. In essence, we address three issues. First, we ask whether data collected from a sample of manufacturers are consistent with the model supported by much of the conceptual literature. We describe that conceptual model in Section 2. Second, we address whether or not manufacturing strategy appears to matter in the larger context of the firm's environment and competitive strategy. In other words, we test whether there is a relationship between manufacturing strategy and business performance when the effects of environment and business-level competitive strategy are also considered. Third, we address the form of the relationship between competitive environment and manufacturing strategy. Specifically, we analyze the extent to which competitive strategy mediates the effects of environmental dynamism on manufacturing strategy.

Environmental dynamism refers to the degree of turbulence in products, technologies, and demand for products in a market (Miller and Friesen, 1983; Dess and Davis, 1984). By competitive strategy we refer to the broad dimensions that a business uses as a basis of advantage, e.g., price vs. differentiation (Porter, 1980). Manufacturing strategy may be thought of as the manufacturing-oriented dimensions that win orders (Hill, 1994). Although the possible mediating effects of competitive strategy on the relationship between environmental dynamism and manufacturing strategy have not been tested previously, the environment has long been identified as an important contingency in conceptual and empirical studies of both competitive and manufacturing strategy (e.g., Skinner, 1969; Hofer, 1975; Van Dierdonck and Miller, 1980).

To address these issues, we employ data from a sample 101 U.S. manufacturers across three industries to estimate a path model using covariance structure analysis. We contrast the behavior of high and low performers by splitting the sample on the basis of business performance. We utilize self-reported performance measures to achieve the performance

split and to analyze performance effects, although we acknowledge the shortcomings inherent in such data.

2. Manufacturing strategy model

A review of the literature in the area reveals that the conceptual model presented in Fig. 1 is a representative view of manufacturing strategy in its context. The model suggests that environmental dynamism affects both competitive strategy and manufacturing strategy. Competitive strategy is cast in a mediating relationship because it intervenes between environmental dynamism and manufacturing strategy (Venkatraman, 1989). The model also implies that competitive strategy directly influences manufacturing strategy. Further, the model suggests that the

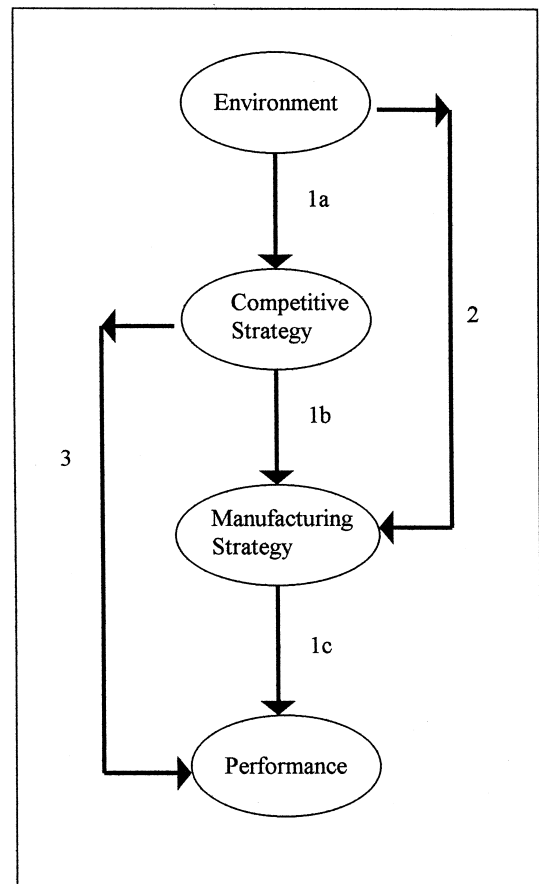


Fig. 1. Conceptual model of manufacturing strategy in its context.

relationship of environment, competitive strategy, and manufacturing strategy is linked to performance. The model also implies that direct links exist between strategies and performance. The numbering of the arrows on Fig. 1 refers to hypotheses developed below.

2.1. Conceptual basis

The model in Fig. 1 is familiar to students of manufacturing strategy. The model's origin can be traced to the seminal paper of Skinner (1969) on manufacturing strategy that prescribed in detail the links among environment, competitive strategy, and manufacturing strategy to achieve good business performance. In their reviews of the operations strategy literature, Anderson et al. (1989) and Leong et al. (1990) find broad support for the conceptual model introduced by Skinner, although relatively little empirical evidence. A contemporary review reveals that this finding still holds. For example, Hill (1994) incorporates environment (especially markets), competitive strategy and manufacturing strategy in his conceptual model, but the model is not tested empirically. A review of the literature also reveals no instance where the connections among environment, competitive and manufacturing strategy and performance implications are considered simultaneously using empirical evidence.

Although no empirical study incorporates all the dimensions represented in Fig. 1, pieces of the conceptual model have been tested. For example, the links among competitive strategy, manufacturing strategy, and performance are addressed by Vickery et al. (1993), who find covariance between competitive strategy and production competence with business performance. Another example of empirical research on the connection between competitive and manufacturing strategies is the numerical taxonomy of manufacturing strategy types of Miller and Roth (1994), which are found to be related to competitive strategies, in some instances. In their study of firms in the textile industry, Williams et al. (1995) find a relationship between competitive strategy and manufacturing strategy and also between manufacturing strategy and performance. Gupta and Lonial (1998) use a path model to test linkages among business strategy, manufacturing strategy, and organizational

performance. None of these studies address the effects of environment on strategy choice nor are the relationships considered simultaneously.

The linkages among environmental dynamism, manufacturing strategy and performance are explored empirically by Swamidass and Newell (1987) and Ward et al. (1995). Both papers show that environmental dynamism is positively related to manufacturing flexibility. The latter paper also finds positive links between environmental dynamism and quality and delivery capabilities among high performers. Both of these studies use path models to establish that environmental factors affect manufacturing strategy and performance, but neither includes competitive strategy in the model.

In contrast with manufacturing strategy research, many empirical studies in competitive strategy have found relationships among environment, competitive strategy, and performance. Keats and Hitt (1988) use a covariance structure model to describe the relationship among several environmental dimensions, competitive strategy, and performance. Miller (1988) supports earlier conceptual work on the types of environmental and strategic configurations that lead to good performance. Kim and Lim (1988) also provide evidence for the model linking environment, competitive strategy, and performance. In general, environmental dynamism is shown to be positively linked with differentiation (as opposed to cost-based) competitive strategies.

2.2. Hypotheses

Our literature review reveals that despite conceptual support for a model linking environment, competitive strategy, manufacturing strategy and performance, simultaneous empirical consideration of all of these aspects has been lacking. We address this deficiency in the literature by considering first the sequential relationships in Fig. 1; those paths directly linking environmental dynamism with competitive strategy (path 1a), competitive strategy with manufacturing strategy (path 1b), and manufacturing strategy with performance (path 1c). Simultaneously testing the existence of these three paths implicitly tests the essence of the conceptual model predominant in the operations strategy literature and addresses the question of whether the model is supported by the

data. We also test whether significant links exist between environment and manufacturing strategy (path 2) and between competitive strategy and performance (path 3). In addition, we test whether businesses that are high performers are more apt to conform to the conceptual model than lower performers.

2.2.1. Fit of the conceptual model

Because of the broad support in the literature, we expect that the model will fit for firms that exhibit relatively high business performance. We distinguish between relatively high and low performers because the literature suggests that low performers are less likely to adhere to the model. For example, Skinner (1969) argues that manufacturing's task has to fit the competitive strategy or failure is almost inevitable. Similarly, Hill (1994) prescribes a strategic process aimed at avoiding misalignments between marketing goals and manufacturing capabilities because such misalignments are frequently causes of poor business performance. Therefore, we expect high performers to adhere to the model and the behavior of low performers to fit the model poorly.

More specifically, we expect to find statistical support for a good fit for a path model directly linking environment, competitive strategy, manufacturing strategy among high performers. This model is depicted in paths 1a, 1b and 1c of Fig. 1. The absence of significant linkages or good model fit among good performers would indicate that the data do not support this conceptual model.

Hypothesis 1: High performers conform to the conceptual model to a greater extent than low performers.

2.2.1.1. Environmental dynamism and competitive strategy. In addition to overall model fit, we test the relationships suggested by each of the paths shown in Fig. 1. In each instance, the literature provides some evidence for the existence of a relationship. For example, the literature is replete with empirical evidence that environment influences strategy. In Section 2, we note several such studies that report a significant relationship between environmental dynamism and competitive strategy. In general these

studies show that more dynamic environments support competitive strategies that are based on differentiation. We expect similar findings from our analysis.

Hypothesis 1a: Environmental dynamism influences competitive strategy choice.

2.2.1.2. Competitive strategy and manufacturing strategy. Although Swink and Way (1995) point out that they are relatively few in number, extant studies do provide empirical evidence of the existence of the predicted linkage between competitive strategy and manufacturing strategy, i.e., that manufacturing strategy supports competitive strategy in high performing businesses. For example, this relationship is borne out by Vickery et al. (1993). It is important to note that a major tenet in the development of manufacturing strategy has been that poor business performance results when manufacturing strategy is not linked with competitive strategy. We test the following hypothesis, expecting to identify a systematic relationship between competitive strategy and manufacturing strategy.

Hypothesis 1b: Competitive strategy influences manufacturing strategy.

2.2.1.3. Manufacturing strategy and performance. The existence of a relationship between manufacturing strategy and business performance has long been supported by the manufacturing strategy literature. For example, Swamidass and Newell (1987) showed that performance was positively related to a particular manufacturing strategy, flexibility. A number of studies have shown that quality is linked with good performance. For example, Ferdows and DeMeyer (1990) and Noble (1995) have argued that effective manufacturing strategies generally begin with quality as a base. Several studies describing world class manufacturers suggest that the best competitors compete on the basis of a variety of manufacturing capabilities (e.g., Flynn et al., 1995b; Ward et al., 1996; Collins et al., 1998). We test the following hypothesis expecting a positive relationship between emphasis on manufacturing capabilities and business performance among high performance manufacturers.

Hypothesis 1c: Manufacturing strategy influences business performance.

2.2.2. *Environment and manufacturing strategy*

The literature also contains evidence of a direct relationship between environmental factors, in particular environmental dynamism, and manufacturing strategy. We earlier cited Swamidass and Newell (1987) and Ward et al. (1995) as examples. In both instances, the researchers also linked business performance to the relationship, suggesting that the high performing firms choose manufacturing strategies consistent with their environments. Because of this evidence, we also test for the existence of a direct relationship between environmental dynamism and manufacturing strategy in the presence of competitive strategy (Fig. 1, path 2). The absence of a significant coefficient for such a path would imply that competitive strategy mediates the effects of environmental dynamism on manufacturing strategy with no significant independent effect.

Hypothesis 2: Environmental dynamism has a direct influence on manufacturing strategy.

2.2.3. *Competitive strategy and performance*

The principle of equifinality suggests that a number of different, equally effective strategies can be used to achieve good performance (Van de Ven and Drazin, 1985; Doty et al., 1993). Strategy implementation is the key link between competitive strategy and success measured by business performance. A number of authors have argued that functional strategy, in general, or manufacturing strategy, in particular, describes such implementation by providing a more detailed picture of how a competitive strategy is pursued (e.g., Hatten et al., 1978; Miller, 1987). We test the significance of the path from competitive strategy to performance to test the importance of the intervention of manufacturing strategy in defining that relationship between competitive strategy and performance (Fig. 1, path 3). The absence of significance for such a link would imply that manufacturing strategy mediates the relationship between competitive strategy and performance rather than having an independent effect.

Hypothesis 3: Competitive strategy has a direct influence on business performance.

3. Data and methods

3.1. *Data*

Data for the study are from a survey of U.S. manufacturing firms. The sample consists of businesses whose primary product is in one of three sectors: fabricated metal products; electrical devices; and electronic controls. The sample is restricted to businesses reporting 150 or more employees at the location. Each firm in the sample was contacted by telephone to identify the top manager resident at that location (for example, general manager) and verify address and line of business. Thus identified, general managers were called and asked to participate in the study. Those who agreed to participate were asked to provide names and addresses for their: (i) plant manager, (ii) marketing manager, and (iii) manufacturing engineering manager. Distinct survey forms were then mailed to each of the four managers so that two independent responses could be elicited for each question from each responding firm. These methods yielded 101 usable responses, a response rate of 37%.

Analysis of the variables used in this research indicates no significant pattern of responses by industry and, thus, no identifiable industry effects. A check for non-respondent bias was carried out by comparing non-respondents with respondents in the same industry on the basis of reported sales volume and number of employees. This check revealed no pattern of differences between the two groups. In telephone interviews with refusing firms, non-respondents' lack of time and reluctance to reveal confidential information were most commonly cited as reasons for not participating.

Each perceptual question is asked of two different managers at the same firm to allow a check on whether each informant's perception is shared by others in the firm. Correlations between the two respondents for each of the scales are all significant at less than 0.01, indicating a high degree of inter-rater agreement and lending support to the validity of the scales.

3.2. Operational definitions

The constructs in the research are made operational using multi-item scales intended to capture the underlying theoretical dimensions. For each construct, we describe briefly both the antecedents or conceptual underpinnings and mechanics used in measurement. The values for each scale are represented as standardized scores. Specific scales are shown in Appendix A.

3.2.1. Environmental dynamism

The environmental dynamism items are adapted from Miller and Friesen (1983). Respondents are asked to indicate the rate of change, from slow to rapid, at which products and services become obsolete, the rate of innovation in product/service and in process, and the rate of change in customers' tastes and preferences. High numeric scores indicate higher rates of dynamism.

3.2.2. Competitive strategy

Porter (1980) developed the idea that all competitive strategies are variants of generic strategies involving a choice between differentiation and delivered cost (price), with degree of focus, i.e., serving niche or broad markets, providing a second competitive dimension. Although many authors have since embellished or modified Porter's generic strategies, they remain useful anchors for classifying strategies (e.g., Miller, 1988). Dess and Davis (1984) provide an instrument to make Porter's generic strategic types operational which has been used frequently in strategy research and is validated by Kotha and Vadlalani (1995). We adapt the instrument and findings of Dess and Davis (1984) to measure the price and differentiation aspects of competitive strategy. Specifically, for cost measures we consider the importance to the business unit of operating efficiency, competitive pricing, procurement of raw materials, minimizing outside financing, decreased number of product features, and reducing product costs. For differentiation, we use the importance to the business unit of new product development, brand identification, innovation in marketing techniques and methods, innovation in products and services, advertising, reputation within the industry, and forecasting market growth. For both cost and differentiation, higher numeric scores indicate greater emphasis.

3.2.3. Operations strategy and competitive priorities

A common theme in operations strategy research has been describing manufacturers' choices of emphasis among key capabilities or competitive priorities. As noted above, the manufacturing strategy literature suggest four competitive priorities: low cost, quality, delivery, and flexibility (Van Dierdonck and Miller, 1980; Hayes and Wheelwright, 1984; Wheelwright, 1984). More recently, Youndt et al. (1996) used these dimensions to operationalize manufacturing strategy. It should be noted that other priorities could be included, notably innovation (Hayes et al., 1988).

3.2.3.1. Quality. Garvin (1987) points out that quality is multidimensional and that each of its dimensions can be used strategically to gain competitive advantage. The quality scale that we use includes items related to the important quality aspect of process control and process management (Flynn et al., 1994). Specifically, the scale measures organizational emphasis on statistical process control, real time process control systems, updating process equipment, and developing new processes for new and old products.

3.2.3.2. Flexibility. The flexibility scale is intended to capture the importance of reducing costs associated with changing products or mix. Specifically, the scale measures the relative emphasis placed on lead-time reductions, set-up time reductions, the ability to change priority of jobs on the shop floor, and the ability to change machine assignments on the shop floor (Gerwin, 1993).

3.2.3.3. Delivery. This measure includes emphasis on customer service as indicated by either delivery reliability or delivery speed.

3.2.3.4. Low cost. The instrument captures the competitive priority of low cost by measuring the emphasis placed on reducing production costs, reducing inventory, increasing equipment utilization, and increasing capacity utilization.

3.2.4. Performance

Business performance is operationalized as a composite of two measures, market share and sales

Table 1

Correlation matrix for full sample (Cronbach's coefficient alphas on the diagonal)

Scale	1	2	3	4	5	6	7
<i>Environment</i>							
1. Environmental dynamism	0.86						
<i>Competitive strategy</i>							
2. Marketing differentiation	0.54**	0.87					
3. Price differentiation	−0.09	−0.04	0.82				
<i>Manufacturing strategy</i>							
4. Low cost priority	0.08	0.24*	0.29**	0.67			
5. Quality priority	0.21*	0.20 ⁺	0.02	0.44**	0.72		
6. Delivery priority	0.10	0.30**	0.13	0.34**	0.18 ⁺	0.78	
7. Flexibility priority	0.21*	0.31**	0.06	0.46**	0.43**	0.30**	0.73

* Significant at < 0.05.

** Significant at < 0.01.

⁺ Significant at < 0.10.

growth, relating to the business unit's perceived position in relation to competitors. Hambrick (1984) suggests dividing the sample into separate high and low performance sub-samples in this manner as a practical analytical technique for strategy research. The scores for the performance measures of market share and sales growth are combined and used to identify 51 high performers and 50 low performers. The questions that measure these items use a Likert scale ranging from 1 to 7 (Appendix A). The scores for the performance measures of market share and sales growth are added to create a scale that ranges from a low of 2 to a high of 14. Based on this composite score, companies are separated into two groups: low performers having performance values of nine or less and high performers having performance values of 10 or more.

In addition to the perceptual performance measures discussed above, we also asked participating firms for objective performance data on earnings growth, although fewer than half of the firms in the sample responded to this questions because the objective data are more sensitive for managers concerned about revealing confidential data. Using a method described by Vickery et al. (1993), the correlation between perceptual and objective measures is used to help validate subjective measures. The objective measure of earnings growth correlates strongly (significant at less than 0.001) with the categorical

variable constructed on the basis of composite perceptual performance, thus buttressing the perceptual measures.

3.3. Reliability

Inter-item analysis is used to check environment, competitive strategy, and manufacturing strategy scales for internal consistency or reliability (Nunnally and Bernstein, 1994). Specifically, Cronbach's coefficient alpha is calculated for each scale, as recommended by Flynn et al. (1990). Cronbach's coefficient alphas, reported in the Table 1, are all acceptable for organizational research according to the criteria established by Van de Ven and Ferry (1978) (pp. 78–81). Table 1 also contains a correlation matrix for the scales described above.

4. Path analytic methods

Causal models have been used in both competitive and manufacturing strategy to link environmental constructs to strategy and performance. Swamidass and Newell (1987) showed environment as a precursor to choice of manufacturing strategy in their path model linking perceived environment, operations strategy process, operations strategy content, and firm performance. Ward et al. (1995) upheld the

contention that environment is causally linked to operations strategy choice for high performing firms. Gupta and Lonial (1998) use a path model to link business and manufacturing strategies. We use a path model to link environment, competitive strategy, manufacturing strategy and performance.

Although the relationships among environment, competitive strategy and manufacturing strategy are often viewed as reciprocal, this study focuses on a single time period in which competitive strategy can be seen as a predecessor of manufacturing strategy and environment is a predecessor to both. These causal relationships were captured by employing path models estimated using covariance structure modeling. We recognize the limitations of using a static model for inferring precedence.

Preliminary path models were first specified to identify the significant relationships and estimate path coefficients. Separate models were estimated for both high and low performance groups. Those covariance paths that were not significant at greater than 0.10 were eliminated to better estimate the model and provide closer fit. Model fit statistics were used to test Hypothesis 1, which requires assessing model fit for high and low performers. Significance tests on coefficients for these same models were used to evaluate hypotheses 1a through 1c, which concern the existence of relationships between environmental dynamism and competitive strategy, between competitive strategy and manufacturing strategy, and between manufacturing strategy and performance, respectively. Covariance of error terms were specified for all manifest variables to account for covariance among factors. Initial path coefficients achieved for the high performer sample are shown in Table 2.

As described in the findings, below, good model fit was achieved for high performers but not for low performers. Therefore, only the high performance sample was retained for subsequent analysis required to test hypotheses 2 and 3. To test hypothesis 2, that environmental dynamism directly influences manufacturing strategy, an additional model was estimated that provides each manufacturing strategy (competitive priority) with both a direct link to environment and an indirect link through competitive strategy. The significance of these path coefficients were used to test the existence of the causal linkages.

Table 2

Path coefficients and significance levels for the initial model

Path	Path coefficient	<i>t</i> Value
Environmental dynamism to		
Marketing differentiation	0.44	3.56*
Price	−0.08	−0.56
Marketing differentiation to		
Low cost	0.25	1.78 ⁺
Quality	0.67	4.16**
Delivery	0.30	2.16 ⁺
Flexibility	0.30	2.13 ⁺
Price to		
Low cost	0.24	1.59
Quality	−0.20	−1.13
Delivery	−0.02	−0.13
Flexibility	−0.04	−0.29
To Performance		
Low cost	−0.04	−0.25
Quality	0.30	1.60
Delivery	0.14	0.82
Flexibility	−0.03	−0.13

* Path coefficient significant at < 0.05.

** Path coefficient significant at < 0.01.

+ Path coefficient significant at < 0.10.

Similarly, to test hypothesis 3, that competitive strategy directly influences business performance strategy, an additional model was estimated that provides a path from each competitive strategy both directly to performance and indirectly through manufacturing strategy. Again, the significance of these path coefficients were used to test the existence of the causal linkages.

5. Findings

Fig. 2 shows the significance of paths and path coefficients that result from estimating the initial model and reducing the model to only paths significant at 0.10 for high performers. Because no single measure of fit adequately describes covariance structure models (Bollen and Long, 1993), Fig. 2 includes three model fit statistics; Root Mean Square Error of Approximation (RMSEA); Bentler–Bonnet normed fit index; and a non-normed fit index. RMSEA estimates the model's fit to the true population parameters taking the number of parameters into consideration. Probabilities are calculated that the RMSEA

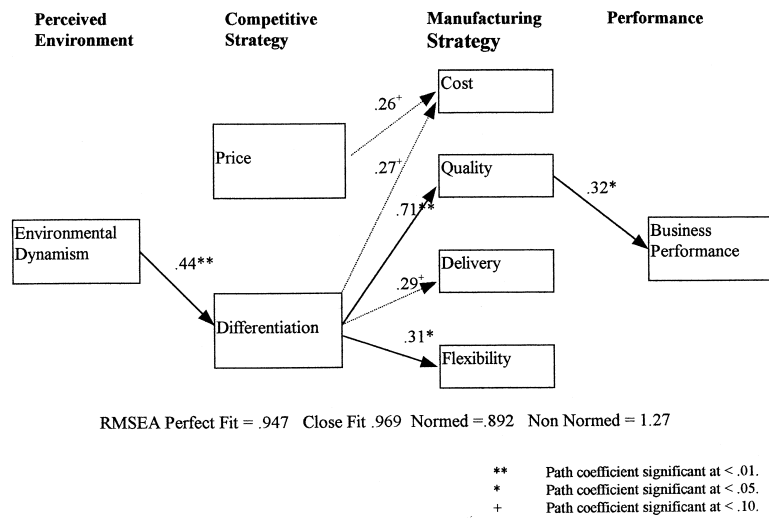


Fig. 2. High performer model.

produces a close fit, i.e., the population discrepancy value approaches zero with significance at 0.05, and the probability of a perfect fit at 0.01. Both the

Bentler–Bonnet normed fit index and the non-normed fit index, which adjusts for degrees of freedom, reflect a comparison with fit indices achieved using a

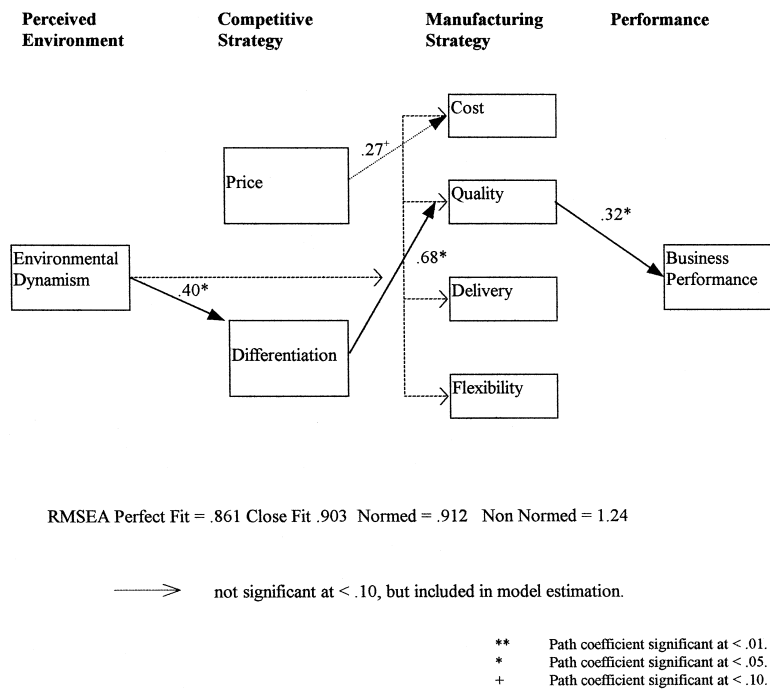


Fig. 3. Direct environmental effects model.

restrictive, baseline model (Bollen, 1989). We specify a baseline model representing covariance among the competitive strategy variables and between the competitive priorities but without paths. For both Bentler–Bonnet and the non-normed fit indices, values close to 1 indicate good fit.

The initial model shows the probability of a perfect fit of 0.947 and a close fit at 0.969, a normed fit index of 0.892 and a non-normed index of 1.27. All fit indices indicate a good fit of the model for high performers. This indication of a good fit substantiates the overall model of the relationship of environment, competitive strategy and manufacturing strategy for high performing firms.

The same model was specified for low performers with dramatically different results. The fit statistics do not indicate a good fit of the model when data from low performers is used. The low performer model shows the probability of a perfect fit of 0.169 and a close fit at 0.275, a normed fit index of 0.673, and a non-normed index of 0.859. The indication of a good fit for the high performer model and poor fit

for the low performing model supports hypothesis 1, that the predominant manufacturing strategy model fits high performers and not poor performers. Because the low performer model fits poorly, subsequent discussion is restricted to the high performance subsample.

The existence of significant paths from environment to differentiation and from competitive strategy variables to manufacturing strategy variables provides evidence of a causal relationship existing between environment and competitive strategy and between competitive strategy and manufacturing strategy. Similarly, a significant path between one of the manufacturing strategy dimensions (quality) and performance also indicates the predicted relationship between manufacturing strategy and performance. These findings support hypothesis 1a, that environmental dynamism affects competitive strategy choice; hypothesis 1b, that competitive strategy influences the selection of an appropriate manufacturing strategy; and hypothesis 1c, that manufacturing strategy is related to performance.

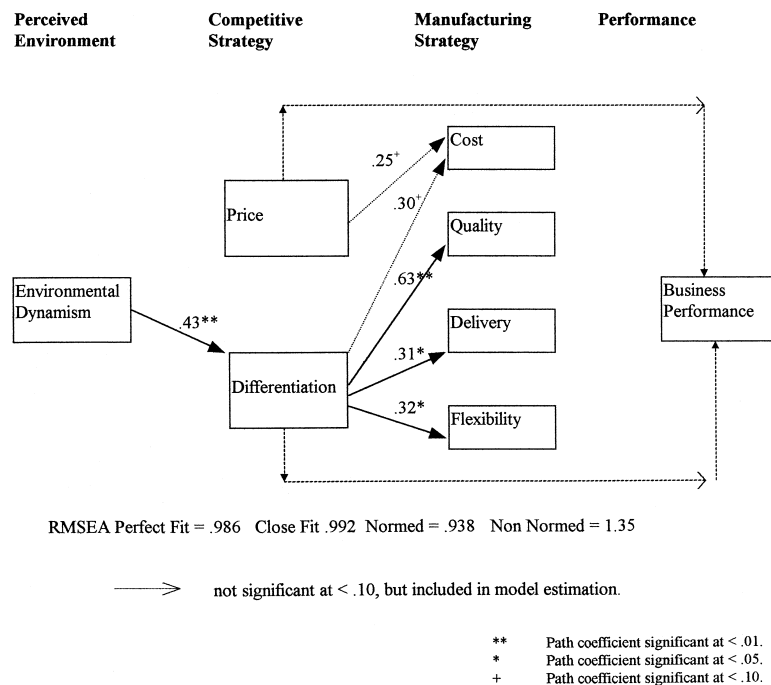


Fig. 4. Direct competitive strategy effects model.

Hypothesis 1a requires that at least one significant path exists between environment and competitive strategy. The path from environmental dynamism to differentiation is significant at the 0.05 level. Similarly, hypothesis 1b requires that at least one significant path exists between competitive strategy and manufacturing strategy. The competitive strategy of differentiation is positively linked to the quality and flexibility dimensions of manufacturing strategy at the 0.05 significance level (with the other paths significant at 0.10). Hypothesis 1c requires that a significant path exist between manufacturing strategy and performance. The path from the manufacturing strategy dimension of quality to business performance is significant at the 0.05 level.

To test hypothesis 2, that a direct relationship exists between environmental dynamism and manufacturing strategy, the initial high performer model was re-estimated with the addition of paths from the environment to manufacturing strategy constructs. Support for hypothesis 2 requires that at least one of these new paths be significant. This model and results are summarized in Fig. 3.

Fig. 3 shows that the four paths from environment to manufacturing competitive priorities are not significant at 0.10. Thus, hypothesis 2, that environmental factors directly influence manufacturing strategy among high performance manufactures, is NOT supported. Because these paths are not significant, there is no compelling evidence of a direct relationship between environment and manufacturing strategy when competitive strategy is also considered.

Finally, hypothesis 3 requires a significant path between either of the competitive strategy variates and business performance. Fig. 4 shows the high performer model respecified to include direct paths from each of the competitive strategy dimensions, price and differentiation, to business performance. Because neither of these paths are significant at 0.10, the data do not provide evidence of a direct competitive strategy–business performance relationship.

In summary, the data support hypotheses 1, 1a, 1b and 1c and thus the conceptual model of manufacturing strategy that has been predominant in the literature. However, the data do not support hypotheses 2 and 3. The implications of these findings are discussed below.

6. Discussion

In essence, this research suggests four notable findings. First, long-standing conceptual arguments linking environment, competitive strategy, manufacturing strategy, and performance are upheld empirically among high performance firms. Second, the model does not fit firms that report relatively poor business performance. Third, we find no direct link between environmental dynamism and manufacturing strategy; rather we find that this relationship is mediated by competitive strategy. Fourth, the data do not support a direct relationship between competitive strategy and business performance. The data suggest that the relationship between competitive strategy and performance is mediated by manufacturing strategy. We elaborate on each of these findings in turn.

6.1. Empirical support for the conceptual model

The tests of the causal model shown in Fig. 2 confirm widely held beliefs about the role of manufacturing strategy in context. Although this finding only confirms what many scholars already hold to be true, it is worth highlighting because such confirmation has not been reported in the literature previously. Although a number of empirical studies have addressed pairs of constructs in the environment–competitive strategy–manufacturing strategy nexus, a review of the literature has not revealed an instance where all three appear in a model simultaneously. In addition, we address the performance implications suggested by the model.

The data analysis also reveals information about the specific nature of the relationships that exist in our sample of high performance manufacturing firms. Recall that we use two predominant competitive strategy dimensions, differentiation and price. Theory and empirical evidence in competitive strategy suggests that differentiation strategies are more effective in dynamic environments (Miller, 1986, 1988; Bourgeois and Eisenhardt, 1988). Our own findings confirm this position, the path between environmental dynamism and a differentiation strategy is significant and positive while the path between environ-

mental dynamism and a low price competitive strategy is not significant (see Fig. 2).

From the perspective of operations management, the paths between each of the competitive strategies and the manufacturing strategy dimensions are of great interest. A competitive strategy of differentiation is linked with each of the manufacturing strategy variables. The coefficient of the paths between differentiation and quality and between differentiation and flexibility are each significant at less than 0.05. Links between differentiation and the other two manufacturing strategy dimensions, low cost and delivery, are significant at 0.10. This finding suggests that successful differentiators pursue a portfolio of manufacturing capabilities to make their offering distinctive in the marketplace. The fact that quality shows the strongest link with differentiation is consistent with the literature (e.g., Garvin, 1987; Williams et al., 1995). As expected, the model reflects a relationship between a low price competitive strategy and a low cost manufacturing strategy, a finding suggested by conceptual literature (e.g., Ward et al., 1996) and common sense. The price–low cost path is significant at 0.10.

The strong link between quality and business performance is also notable. This finding is consistent with both the vast body of TQM research that suggests that a quality emphasis is primary. It is also consistent with a number of empirical studies that suggest a positive relationship between quality and various measures of business performance (e.g., Buzzell and Gale, 1987; Flynn et al., 1995a; Williams et al., 1995). Findings reported by Narasimhan and Jayaram (1998) suggest programs that are antecedents to making progress in achieving competitive priorities, including quality.

The importance of the close coupling between competitive and manufacturing strategies among high performance manufacturers raises interesting questions about how such coupling can be accomplished. Hill (1994) provides one methodology for achieving such a coupling and also points out many potential pitfalls in the process. Adam and Swamidass (1989) and others point out that manufacturing strategy process research has been neglected relative to content research. The (content research) findings reported here underline the importance of process research for developing an understanding how firms

establish close linkages between competitive and operations strategy without adopting bureaucratic strictures that impede responsiveness.

6.1.1. Poor fit for poor performers

A number of authors have suggested the consequences of not adhering to a manufacturing strategy model that ties business and manufacturing strategy: poor performance (e.g., Skinner, 1969; Hill, 1994). Our findings of poor model fit for poor performers are consistent with the admonitions of these and other influential thinkers in our field. Our findings also suggest the practical advice for empirical researchers in our field, separate consideration of high and low performers. Hambrick (1984) specifically recommends splitting a sample based on performance to capture the different behaviors in strategy research using a configurational approach. Other approaches suggest different means for achieving separation but the idea that poor performers behavior may be fundamentally different from good performers is worthwhile.

6.2. Environmental dynamism and manufacturing strategy

At first glance, the finding of no direct relationship between environmental dynamism and manufacturing strategy appears at variance with the empirical findings reported by Van Dierdonck and Miller (1980), Swamidass and Newell (1987) and Ward et al. (1995). The apparent inconsistency is easily explained, however, by the fact that none of the studies noted above considered environment and competitive strategy simultaneously. Our findings indicate that competitive strategy mediates the effects of environmental dynamism on manufacturing strategy in high performance firms.

Testing for mediation is usually done in a path analytic framework similar to the one used in this research. The significant paths between environmental dynamism and competitive strategy and between competitive strategy and manufacturing strategy cast competitive strategy as a mediator (Venkatraman, 1989). The fact that there is not a direct path between environmental dynamism and manufacturing strategy provides stronger evidence of mediation (i.e., evidence of complete mediation, Blalock, 1969;

Venkatraman, 1989). The mediating effect of competitive strategy suggests that environmental dynamism has an important influence on manufacturing strategy but that influence is articulated through and modified by competitive strategy.

The research implication of competitive strategy mediating the effects of environment on manufacturing strategy is clear. A model of manufacturing strategy must include both environmental and competitive strategy variables to capture the context of manufacturing strategy accurately. Previous empirical research in manufacturing strategy generally excludes from consideration either environment or competitive strategy. Our results suggest that overlooking either environment or competitive strategy may miscast the true relationships. Therefore, it is important to assess manufacturing strategy in the context of both environment and competitive strategy. In short, the data suggest that for high performance manufacturers, reactions to environmental conditions are effected through competitive strategy. This only underscores the importance of a close coupling of competitive and manufacturing strategies and, again, implies that learning how to make effective links between competitive and manufacturing strategy is critical.

6.3. Competitive strategy and performance

Our analysis suggests that the relationship between competitive strategy and business performance is mediated by manufacturing strategy. More specifically, the quality dimension of manufacturing strategy appears to mediate the differentiation strategy–business performance connection. This finding implies that a differentiation strategy works when it is supported by manufacturing capability, i.e., quality.

This implication is important because it suggests that performance improvements resulting from competitive strategy initiatives are manifested in their implementation via manufacturing capabilities, specifically quality. By using more precise instruments to measure competitive strategy, future research may discern that other dimensions of manufacturing strategy also serve to define the performance effects of competitive strategy.

The emerging paradigm of manufacturing strategy that appears in the literature suggests tight constellations of environmental factors and strategies which lead to superior capabilities and performance (e.g., Miller and Roth, 1994; Hayes and Pisano, 1996). Our study supports this view of manufacturing strategy. In addition, we test and support a model of manufacturing strategy that is predominant in the conceptual literature for high performers but show that this model does not fit for low performers. This research also shows that competitive strategy is a mediator between environment and manufacturing strategy for high performing firms. Perhaps most notably, the findings provide empirical evidence that manufacturing and competitive strategies are inextricably linked in high performance firms. This suggests that research into the processes that companies use to achieve those links is of great importance for moving forward our knowledge of manufacturing strategy.

Acknowledgements

We thank the Ohio State University's Center for Excellence in Manufacturing Management for financial support. Errors remain the responsibility of the authors.

Appendix A. Items used for developing scales

Environmental dynamism

Indicate the rate of change for the following

	Slow						Rapid	N/O
• The rate at which products and services become outdated	1	2	3	4	5	6	7	9
• The rate of innovation of new products or services	1	2	3	4	5	6	7	9
• The rate of innovation of new operating processes	1	2	3	4	5	6	7	9
• The tastes and preferences of customers in your industry	1	2	3	4	5	6	7	9

Competitive strategy

Rate the following competitive methods on how important they are in meeting your business strategy

	No importance		Very important		Absolutely critical		N/O	
Price								
• Operating efficiency	1	2	3	4	5	6	7	9
• Competitive pricing	1	2	3	4	5	6	7	9
• Procurement of raw materials	1	2	3	4	5	6	7	9
• Reducing product costs	1	2	3	4	5	6	7	9
• Minimize outside financing	1	2	3	4	5	6	7	9
• Decreasing the number of product features	1	2	3	4	5	6	7	9
Differentiation								
• New product development	1	2	3	4	5	6	7	9
• Brand identification	1	2	3	4	5	6	7	9
• Innovation in marketing techniques and methods	1	2	3	4	5	6	7	9
• Control of distribution channels	1	2	3	4	5	6	7	9
• Advertising	1	2	3	4	5	6	7	9

Manufacturing strategy

Indicate the degree of emphasis which your manufacturing plant places on the following activities

	No emphasis		Moderate emphasis		Extreme emphasis		N/O	
Flexibility								
• Lead-time reduction	1	2	3	4	5	6	7	9
• Setup time reduction	1	2	3	4	5	6	7	9
• Ability to change priorities of jobs on the shop floor	1	2	3	4	5	6	7	9
• Ability to change machine assignments of jobs on the shop floor	1	2	3	4	5	6	7	9
Quality								
• Statistical process control	1	2	3	4	5	6	7	9
• Real-time process control systems	1	2	3	4	5	6	7	9
• Updating process equipment	1	2	3	4	5	6	7	9
• Developing new processes for new products	1	2	3	4	5	6	7	9
• Developing new processes for old products	1	2	3	4	5	6	7	9
Delivery								
• Provide fast deliveries	1	2	3	4	5	6	7	9
• Meet delivery promises	1	2	3	4	5	6	7	9
Cost								
• Reduce inventory	1	2	3	4	5	6	7	9
• Increase capacity utilization	1	2	3	4	5	6	7	9
• Increase equipment utilization	1	2	3	4	5	6	7	9
• Reduce production costs	1	2	3	4	5	6	7	9

Performance

Compared to your competitors, indicate your position on the following dimensions

	Significantly Lower				Equal				Significantly Higher				N/O
• Market share	1	2	3	4	5	6	7	8	9	10	11	12	13
• Sales growth	1	2	3	4	5	6	7	8	9	10	11	12	13

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