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Performance: An Empirical
Analysis of Brazilian
Manufacturing Companies**

André Luís de C. Moura Duarte

Luiz Carlos DiSerio

Luiz Artur Ledur Brito



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OPERATIONAL PRACTICES AND PERFORMANCE: AN EMPIRICAL ANALYSIS OF BRAZILIAN MANUFACTURING COMPANIES

André Luís de Castro Moura Duarte

Luiz Carlos DiSerio

Luiz Artur Ledur Brito

IBMEC São Paulo

Fundação Getúlio Vargas – São Paulo

Fundação Getúlio Vargas – São Paulo

ABSTRACT

This paper used the SEADE database on 1,200 manufacturing companies, located in São Paulo state, active in 14 different industries, to test the relationship between certain operational practices, such as quality, just in time, ISO certifications and level of outsourcing with organizations' performance. The study used a multiple regression technique and performance was measured in terms of Profitability and Revenue Growth Rate. Generally, no relationship between these practices and performance could be found. The findings were unable to support the large body of literature in operations management that establishes this link based on anecdotal evidence. Level of outsourcing was the only consistently related variable, negatively related with both profitability and growth.

Keywords: operational practices, performance, resource-based view

INTRODUCTION

Operational practices are internal factors that contribute to competence development; therefore, they can offer competitive advantages for firms (HAYES; PISANO, 1996). In this sense, both the operations strategy and the resource-based view - RBV (WERNERFELT, 1984; BARNEY, 1991) support the notion that operating practices create competences that can be used as weapons for firms to secure a competitive edge.

Operations Strategy comprises a set of structural and infrastructural decisions that assist and support the organization's definition of its competitive priorities (HAYES *et al.* 1988). Operating practices, in turn, help attain those competitive priorities and should therefore play a significant role in organizational performance.

The theory of RBV, in its turn, regards the firm as a set of superior resources that provide firms with competitive advantages that are sustainable over time (WERNERFELT, 1984; BARNEY, 1991). RBV argues that organizations, even within a single industry and the same competitive environment, are heterogeneous as concerns their assets. This heterogeneity might explain these organizations' competitive differentials. RBV understands assets to be any resources of value to the organization, both tangible (machinery, equipment, etc.) and intangible (knowledge, competences, production process practices, etc.) (WERNERFELT, 1984; TEECE *et al.*, 1997). The empirical evidence that firm effects are relevant in explaining the variability of performance is now

established through the line of research on performance variance components (RUMELT, 1991; McGAHAN and PORTER, 1997). This has also been confirmed to be the case for Brazilian companies (BANDEIRA DE MELLO; MARCON, 2005; BRITO; VASCONCELOS, 2005; MORAES, 2006).

Therefore, most empirical studies in the field of operations strategy have been based on RBV insofar as they explore resource heterogeneity as a source of competitive advantage. In other words, Operations Strategy researchers have been searching RBV for resource heterogeneity-based arguments to explain firm performance variation. Ketokivi and Schroeder (2004) show that one of the main proposals of operations strategy studies is to identify superior performance indicators and, more recently, sustainable competitive advantage drivers. The same authors argue that operations strategy researchers have contributed to the literature by examining under what conditions specific practices, resources or structural arrangements become valuable to the organization.

Two kinds of research are being conducted in the realm of operations strategy: one based on in-depth case study within the unique and exclusive context of a specific firm; and another based on surveys. The former lacks information capable of generalizing aspects of the phenomenon at hand; the latter only allows more superficial analysis, but provides more statistically general results.

Gagnon (1999) understands that one of the main fields for operations management research, which has been borrowing from RBV to develop new theories, is the study of world-class practices implementation. These studies deal not only with how to implement best practices, but also with the impact these practices have on firm performance. Behind this view lies the notion that world-class practices such as Just in Time, Total Quality Management, ISO, Re-engineering, and Outsourcing must be treated as means to improve processes so that firms can develop the skills and competences to become more competitive in the long run.

More recently, Narasimham *et al.* (2005) note that empirical operations strategy and world-class manufacturing studies have focused on identifying best practices, developing taxonomies and investigating how these practices connect with organizations' performance. Another research thread in manufacturing strategy links best practices, production process skills and competences and the organization's ability to attain low costs, high flexibility, reliability and quality (HAYES; WHEELWRIGHT, 1984).

The main motivation for this study comes from the centrality and relevance of how operating practices affect firm performance and the opportunity to explore a broad census database of São Paulo State firms, the SEADE Base (*Serviço Estadual de Análise de Dados Estatísticos* — State Statistical Data Analysis Service). The SEADE base consolidates the PAEP (*Pesquisa da Atividade Econômica* — Economic Activity Survey) surveys for 1996 and 2001, covering 3,579 firms with data for both years. This survey addresses a series of intrinsic firm traits, including several operating practices of relevance to operations strategy, which allows exploring this relevant issue in the Brazilian context, where previous surveys are even more limited. This study analyzes a sample of 1,200 firms in 14 manufacturing industries.

More specifically, this study aims to test the relationship between operating practices (JIT, quality, ISO certification and services outsourcing) and organizational performance. The selected organizational performance metrics are Profitability and revenues growth rate between 1996 and 2001.

The next section provides a brief review of the theoretical fundamentals of these organizational practices, focusing on studies that also attempted to investigate how they related with firm performance. Our methodology is then introduced. Results are provided and discussed next, and a final section summarizes our findings and discusses certain constraints.

OPERATING PRACTICES AND FIRM PERFORMANCE

Assuming that internal factors at firms are primarily responsible for performance variation, organizations are expected to make changes based on “best practices” to their structural and

infrastructural elements in order to attain selected performance goals (NARASIMHAN *et al.* 2005). For Hayes and Pisano (1996), firms are on performance curves based on the resources they use, but new manufacturing technologies, including management-related ones, such as JIT and TQM, might place firms on new performance curves.

We next provide a review of the literature that investigates the impact of operating practices — in particular JIT, Quality, ISO certification and Outsourcing — on firm performance.

Quality and Performance Practices

TQM can be defined as a management philosophy that integrates with a series of practices emphasizing continued improvement, meeting consumer expectations and needs, reducing re-work, long-term planning, redesigning processes, competitive benchmarking, teamwork, constant results measurement, and a close relationship with suppliers (ROSS, 1993 *apud* POWELL, 1995). Total Quality Management (TQM) is one of the philosophies firms apply to improve processes but, in spite of how widespread it is, the literature has not achieved consensus on a definition and, above all, on the quality practices TQM adopts. Slack *et al.* (2002) confirm this view, arguing that many authors use the same language, but different dialects, to define TQM. In fact, Kaynak (2003) carried out a comprehensive review of TQM literature, identifying different practices operations researchers attribute to TQM.

The results of several of the empirical studies on ties between quality practices and organizational are mixed. Powell (1995), for example, uses RBV to study the impact of some elements of Total Quality Management — TQM programs on the creation of competitive advantage. The author surveyed a relatively small sample of 39 US firms that had implemented total quality programs. Performance was measured subjectively through the firms' profitability and growth. The results suggest that practices associated with TQM programs are not capable of generating sustainable competitive advantages, but some of the characteristics present in quality programs help form intangible and behavioral elements such as leadership, organizational skills and culture that are subject to imperfect imitation and allow creating a sustainable competitive advantage.

Kaynak (2003) contributed to the discussion with a comprehensive review of the literature. The author investigated the links between the different TQM practices, attempting, in particular, to determine how they affect organizational performance on three levels: operational, marketing and financial. The results of her survey with 382 business units support the argument that only a few TQM practices (supplier quality management, product/service project, and process management) have a positive effect on an organization's operational performance. The same practices also affect financial and marketing performance through the organization's operational performance.

Cho and Pucik (2005) examined the relationship between quality, innovation, growth, profitability and the firm's market value. The authors used 488 firms in 10 different industries. The results of the structural equations model show that quality has different effects on profitability and growth. While the quality has a direct impact on profitability, its effect on growth is mediated by innovation.

The work of Brito, Csillag and Brito (2006) on Brazilian National Quality Award (*Prêmio Nacional da Qualidade* — PNQ) contestants supports the findings of Cho and Pucik (2005), as it suggests a positive connection between TQM and profitability; however, they find no relationship with the growth rate.

On the other hand, Mohrman *et al.* (1995), were unable to use financial statistics to find a connection between adopting TQM and financial performance. Still, some positive ties were found between TQM and market share. As concerns operating variables, the authors found a significant positive relationship between TQM and employee efficiency.

In a recent empirical study, Sila (2007) tested the impact of TQM practices on certain organizational performance variables. The results show that a direct relationship exists between

TQM practices and organizational efficiency, but no significant connection was found with either financial or market performance. Only indirect effects of TQM made themselves felt on these two latter performance variables.

Based on all of the above studies, we may say that some positive connection may be expected between quality and performance, but this relationship is not always direct, as suggested by some researchers. Furthermore, some results are difficult to compare and, in addition, conflicting.

JIT (Just In Time) and Performance

Some of the articles on the relationship between JIT and organizational performance also deal with TQM practices and the relationships between TQM and JIT, as the two philosophies have several practices in common, as we will see ahead.

Literally, JIT means producing goods and services exactly when they become needed, not before or after. Slack *et al.* (2002) divide JIT into philosophy and a series of techniques. The philosophy of JIT helps guide the actions of an organization's managers and is based on doing things well and simply, improving them constantly, eliminating waste and all of this with the involvement of everyone in the organization. JIT as a set of techniques and tools represents the means to attain the fundamentals the philosophy prescribes.

Some of the main elements of JIT are also to be found in the TQM philosophy. The two philosophies are rather interconnected, particularly through constant improvement, the involvement of all in the organization, and the elimination of waste (FLYNN *et al.*, 1995). Kiran *et al.* (1995) point out the relationship and synergy found between TQM and JIT. The authors argue that firms the implement both philosophies jointly attain better performance than those that view and implement them in isolation.

Several of the authors who empirically investigated the benefits of JIT, such as Bartezzaghi *et al.* (1992) and Upton (1998), focused their studies on the benefits relative to organizations' operating performance, including reduced lead time, production time and procurement batches, increased process flexibility, accelerated delivery, low cost and low cycle time, to name a few. As a result, these authors found significantly improved operational efficiency.

Claycomb *et al.* (1999) surveyed executives with 200 American organizations. The authors also found a positive relationship between JIT and financial and efficiency metrics. The main source of criticism against this study was based on its use of a primary database with subjective performance metrics.

Fullerton *et al.* (2003) surveyed 95 firms that had implemented JIT and 158 firms without JIT in various US manufacturing industries. The authors divided JIT practices into three variables: Quality JIT (improved product and process quality), Manufacturing JIT (focused plant, group technology, reduced setup time, productive maintenance, multi-purpose employees and uniform work-load), and exclusive JIT techniques (Kanban and JIT procurement). They found that firms with a broader adoption of the JIT approach were able to attain better financial performance. But no significant correlation was found between exclusive JIT variables (Kanban and JIT procurement) and profitability. The authors were also unable to find a positive correlation between the Manufacturing JIT variable and profitability, and a negative correlation between Quality JIT and profitability. Finally, the authors show that no significant evidence exists that firms with JIT become more profitable over the years.

Sale and Inman (2003) also performed an empirical comparison between JIT and TOC (Theory of Constraints) adopters and traditional manufacturers. Their results show that the best performance and greatest evolution were found with firms that had implemented TOC. JIT firms had no better performance than traditional manufacturers. In addition, they showed no performance improvement after implementing JIT.

We can see that here, too, no consensus exists among the various researchers as to whether JIT can truly improve an organization's financial performance. Even so, several studies showed

improved operations performance. Another interesting view can be found in Fullerton *et al.* (2003), who argue that use of JIT is more closely related with long-term performance gains. Therefore, adoption of JIT is not supposed to bring about immediate return on investment. According to the authors, this partly explains the low validity and consistency of empirical surveys attempting to show a relationship between financial performance and JIT adoption.

ISO Standards and Performance

The ISO (*International Organization for Standardization*), translated as ISO standards, was first published in the late 1970s and quickly became a benchmark for quality management. This study takes account of two ISO standards: ISO9000 and ISO14000.

ISO 9000 means to assure that products and services purchased have been produced in a way that meets the buyer's needs. This is done by means of the definition of a firm's quality control system's procedures, standards and characteristics. ISO 14000, in turn, aims to create an environmental management system to assist organizations in demonstrating their compliance with environmental standards.

Concerning ISO 9000, Gotzamani and Tsiotras (2001) take up the importance of getting employees involved in the extraction of benefits from certification. The main results of their study suggest that ISO 9000 certification favors subsequent efforts towards implementing TQM practices, as the organization's quality gains become more evident after the certification. With improvements in the "hard" aspect of the processes, the authors suggest that firms should focus only on the "soft" aspects of TQM, such as leadership and organizational culture.

In terms of competitive performance, Heras *et al.* (2000) made headway with the finding that the causal link lies not in the direction of "certified firms have perform better than uncertified ones." In fact, the causal link is "firms with better financial performance are more likely to get ISO 9000-certified." The authors suggest some hypotheses as to why this might be. According to them, the systems certification requires generate high implementation and maintenance costs, which makes highly profitable firms more likely to implement than others. In the same sense, larger firms could better dilute those costs across their operations, which smaller firms lack such a choice. Finally, more profitable and bigger firms tend to compete internationally. Because global players make efforts to become "world-class firms" based on their quality management systems, certification becomes a seal of assurance that helps entered and operate in certain international target markets.

More broadly, Rao and Holt (2005) show that the economic performance of ISO 14001-adopting firms is not associated with internal processes only, but also with their suppliers and customers. Or, in other words, with the firm's entire supply chain.

The most remarkable result of Rao and Holt (2005) is that firms must integrate their suppliers into the adopting of environmentally correct practices, as this is crucial to successfully reducing production-process waste and residue. As for competitive gains the study shows that supply chains with integrated environmental practices ("green chains") not only achieve substantial cost reductions, but can also expand sales and market share and even exploit new commercial opportunities.

As seen in this section, not many works investigate the relationship between ISO standards and performance and, in particular, ISO standards and financial performance. In most studies, this assessment is more qualitative than quantitative.

Outsourcing And Performance

Lei and Hitt (1995) define outsourcing as reliance on a certain outside source of manufactured components or value-added activities. Gilley and Rasheed (2000) attempt to clarify the concept of outsourcing, defining it as the purchase of a good or service that was originally produced internally, or might have been produced internally, but was in fact produced by a supplier.

At least two strong ties can be found between the outsourcing and RBV. Prahalad and Hamel

(1990) were the first to operate with the idea that firms should focus on their core competences to become more competitive, thereby avoiding the waste of efforts on secondary activities. Bear in mind that the concept of focus, as discussed earlier, was introduced by Skinner's (1969) more strategic view of a firm's operations.

Teece (1986), another influent RBV author, also made a contribution to understanding outsourcing through the concept of complementary assets. According to this author, a firm should strike partnerships with firms that whose resources may complement its own, turning this into a differential from the competition and thereby getting a competitive advantage over competitors.

According to Jiang and Qureshi (2006), outsourcing became more popular as an operating strategy beginning in the 1990s. Increased global competition, pressures to reduce fixed costs, downsizing trends, a focus on core competencies, and the pursuit of flexibility led many firms to choose to outsource products and services that were previously produced internally. For these authors, outsourcing is now one of the latest managerial strategies in the pursuit of organizational competitiveness.

Londsdale (1999) suggests that only 5 percent of the surveyed firms attained significant benefits from outsourcing. Despite growing use, its results as an operations management practice remain vague. In this sense, Jiang and Qureshi (2006) write:

However, despite the growing emphasis of outsourcing, researchers are unable to empirically and systematically pinpoint its impact on firm's performance metrics by using objective "hard data," which are from audited financial reports.(JIANG; QURESHI, 2006, p.44).

Jiang and Qureshi (2006) say that most studies focused on understanding the determinants of the decisions to outsource and on control over the outsourcing process, and few empirical, results-focused studies are to be found from the literature. The reasons for this include: a) trouble quantifying economies or gains from outsourcing, which tend to be higher at first and lower as time passes; b) the constantly changing competitive environment, which makes gains from outsourcings done in previous years difficult to compare; c) economies are often not localized in a certain department, but occur across the firm as a whole; and d) where the objective of an outsourcing process is other than cost reduction, financial data are not even recorded.

Jones (2000) was interested in assessing the impact of outsourcing on the Research and Development (R&D) area of pharmaceutical companies. The results of the survey show a 5-16 percent increase in firms' R&D cost when they choose to outsource this service. The limitation of Jones (2000) lies in the fact that it studies the impact of outsourcing on the R&D sector only, rather than on the firm in its entirety.

Barrar *et al.* (2002) used DEA (Data Envelopment Analysis) to compare the efficiency of firms that outsource their accounting services and of those that do not. The survey shows that outsourcing accounting services is more efficient in terms of productivity, this being the sole metric the authors used.

The last article mentioned in Jiang and Qureshi (2006) was Hays *et al.* (2000), where the authors investigate the impact of outsourcing on share prices. Hays *et al.* (2000) find empirical evidence that outsourcing has a positive effect on stock prices.

More recently, Jiang, Frazier and Prater (2006) did a broader empirical research with a focus on results. The authors assessed the results of outsourcing in terms of three distinct performance variables: cost, productivity and profitability. The authors used a sample of 51 American firms, 27 in the agricultural and manufacturing industries, and 24 services providers. The study showed evidence that outsourcing may improve a firm's costs, but failed to find that it can improve an organization's profitability and productivity.

METHODOLOGY

This study used a secondary database called PAEP (*Pesquisa da Atividade Econômica Paulista* —

São Paulo State Economic Activity Survey) and prepared by SEADE (*Fundação Sistema Estadual de Análise de Dados* — State Data Analysis System Foundation). PAEP was first produced in 1997-1998 with data for 1996; the second survey, done in 2002-2003, was based on São Paulo State economic activity in 2001. This study will only take into account the manufacturing firms that took part in both the 1996 and 2001 surveys. Our initial sample therefore comprises 3,579 manufacturing firms in the State of São Paulo.

Table 1: Selected industries and firms.

CNAE Code	Industry	Firms
158	Manufacturing, other food products	82
181	Garments tailoring	107
193	Manufacturing, footwear	74
213	Manufacturing, paper or cardboard containers	50
251	Manufacturing, rubber articles	56
252	Manufacturing, plastic goods	190
264	Manufacturing, ceramic products	96
283	Forging, Stamping, powder metallurgy and metal-treatment services	75
289	Manufacturing, various metallic products	112
292	Manufacturing, general machinery and equipment	65
296	Manufacturing, other specific machinery and equipment	66
344	Manufacturing, automotive parts and accessories	104
361	Manufacturing, furniture	65
369	Manufacturing, various products	58
TOTAL		1200

We chose to use only single-location ones, that is, firms with only one manufacturing unit in the State of São Paulo. This is due to the fact that PAEP provides aggregate organization data, that is, data on an organization's various manufacturing units. Using information on single-location firms increases data reliability, as responses to the questionnaires always concerned that particular unit. The main implication of this choice was removal from the sample of a significant share of larger firms that normally have more than one manufacturing unit.

For the purposes of this study, a categorization was created from the first three digits of the CNAE code (an industry classification similar to NAICS). The purpose was to group together the largest possible number of firms with similar characteristics. Because some three-digit industries were left with a reduced number of firms, and to facilitate the analysis, we chose to work only with industries with 50 or more firms. Table 1 shows the industries and the number of firms.

The sample is not probabilistic and, therefore, the results have no outside validity and the conclusions cannot be generalized; still, the sample is large enough to be regarded as a contribution to business administration knowledge in the specific area of operations management. Another aspect is that the original PAEP database is a census of all firms with more than 30 employees.

The study uses two variables to measure firm performance: a profitability estimate and the revenue growth rate, as seen in the equations (1) and (2):

$$\text{Profitability (P)} = \frac{\text{Total Revenue}_{2001} - (\text{Total Expenses}_{2001} + \text{Total Wages}_{2001})}{\text{Total Revenue}_{2001}} \quad (1)$$

$$\text{Revenue Growth Rate (RGR)} = \frac{\text{Revenue}_{2001} - \text{Revenue}_{1996}}{\text{Revenue}_{1996}} \quad (2)$$

The operating practices variables are the study's main independent variables. They were construed using indicators available in the database. The rationale and the detailed

operationalisation are described in sequence.

- **Quality Practices (Q):** formed from a set of quality-related programs, methods and techniques adopted by the surveyed firms. The bigger the number of methods and techniques a firm uses, the greater the variable for the firm. The survey measures the adoption of eight quality practices: total preventive maintenance, kaizen, use of mini-plants, total quality management, quality auditing, statistical process control, quality indicators, and final inspection. We created a variable that counts the number of practices said to be adopted by each company. The variable ranges from zero to eight, depending on the number of practices each firm adopts. Strictly speaking, this is a categorical variable, but may be regarded as ordinal, assuming that the larger the number of practices, the more intense the use of quality management practices in general. In its use as an independent variable in regressions, however, it is treated as an interval variable, which is a brave approximation at the very least. This treatment assumes that differences in an additional practice are equivalent across the scale, which is unlikely to have conceptual grounds. But the procedure may lead to an acceptable approximation where the dependent variable is monotonic and a large number of data is used (NUNNALLY; BERNSTEIN, 1994).
- **Just-in-Time Practices (JIT):** the original survey has two items to measure JIT, one exploring internal JIT and the other external JIT. A dummy variable was created with the value of zero if the company used neither internal nor external JIT and taking the value of one when the company practiced either one of them.
- **ISO Standards (ISO):** the original survey also had two items related to ISO. One identifying the usage of ISO9000 standards and another with ISO14000. A similar approach to JIT was used. A dummy variable was created with the value zero for companies that used neither ISO9000 nor ISO14000 and with the value 1 if the company used either one.
- **Services Outsourcing Level (O):** a continuous interval variable was defined based on each manufacturing firm's expenditures in the purchase of services provided other suppliers. We therefore assume the level of outsourcing to be the level of spending on the purchase of services from third parties.

The variable was calculated as follows:

$$\text{Service Outsourcing Level (O)} = \frac{E_{\text{natural entities}} + E_{\text{legal entities}}}{\text{Revenue}_{2001}} * 100 \quad (3)$$

Beside operating variables, two control variables were used. Control variables are factors the investigator purposefully neutralizes or cancels out in a study to prevent them from interfering with the analysis of the relationship between the study's independent and dependent variables (LAKATOS; MARCONI, 1985). The control variables used here were selected based on their possible influence on dependent variables and the study's other independent variables. The following control variables are used:

- **Revenue (R):** the firm's total 2001 revenues in Brazilian Reais (R\$). Represents firm size, under the assumption that bigger firms will have bigger revenues;
- **Age (A):** a firm's age in years.

In order to compare the results of firms in different industries, we chose to standardize certain variables based on the industry's mean and standard deviation. Variables standardized based on the industry's mean were: Revenue, Age, Services Outsourcing Level and Profitability. Standardization transformed the mentioned variables as being a certain number of standard deviations above or below the industrial mean, thereby minimizing industries' effects on the analysis.

A second treatment was also needed for the variables Revenue and Revenue Growth Rate. Because of the highly asymmetrical data and in order to reduce the distance between extreme measurements, a log transformation was used to create the variable LnStandardized Revenue (LnStR) and the variable Revenue Growth Rate ($\text{RevenueGR} = \ln\text{Revenue}_{2001} - \ln\text{Revenue}_{1996}$).

To answer the study's questions we use the statistical tools of Correlation Analysis and Multiple Regression. Correlation analysis provides a number that indicates how two variables, X and Y, vary together, an indicator that meets the need to establish whether or not a relationship exists between the two variables. Regression analysis goes beyond correlation analysis insofar as, besides measuring the association between output variable Y and a set of independent variables (X_1, X_2, \dots, X_p), it also estimates the parameters of the systematic behavior across them (LIRA, 2004, p.1).

Two regressions were run for each dependent variable: one using production variables only, indistinctly for the various manufacturing industries, as the dependent variables are standardized by industry; and another with a set of dummy independent variables by industry. Interaction between dummy industries and other independent variables were also tested. Because industry-effect was already addressed through variable standardization, the idea was to explore different industry-related links between other independent variables and the dependent variable. The purpose of this second regression is to investigate whether production variables may exert different influence in different industries. Regressions used the stepwise variable-selection method.

RESULTS AND ANALYSES

We begin with a correlation analysis to determine whether or not a relationship exists between the study's dependent and independent variables. Table 2 shows how these variables relate.

Generally speaking, correlations between dependent and independent variables are low. The largest positive correlations seen in Table 2 are among operating variables Quality, JIT and ISO. This simply proves that, as noted by other authors, these practices are inter-related, have practices in common and often support one another (FLYNN *et al*, 1995; GOTZAMANI; TSIOTRAS, 2001).

Table 2: Analysis of the correlation among independent and dependent variables

	RevenueGR` 2001	LnStR` 2001	StA ₂₀₀₁	StT ₂₀₀₁	Q	JIT	ISO
StPROFIT ₂₀₀₁	0.167*	0.209*	-0.002	-0.092*	0.038	0.005	0.050
RevenueGR`		0.436*	-0.127*	-0.076*	0.080*	0.082*	0.029
LnStRa ₂₀₀₁			0.101*	0.063*	0.229*	0.153*	0.245*
StA ₂₀₀₁				0.089*	-0.030	0.004	-0.023
StT ₂₀₀₁					0.041	0.001	0.066
Q						0.432*	0.471*
JIT							0.280*

Note: *Pearson correlation coefficient significant at 5 percent

Firm-size, represented by the revenue variable, also appeared to have a positive, but weak, relationship with Quality, JIT and ISO practices; and a negative correlation with Service Outsourcing Level. In addition, it had a stronger correlation with the variables Profitability and, in particular, Revenue Growth Rate.

The first regression model presented used the dependent variable Profitability. The goal was to determine how much of the variation of the StPROFIT variable could be explained with the firm's production variables. The results of this model can be seen in Table 3. The model explained only 6.9 percent of the variation of Profitability (StPROFIT₂₀₀₁) through variables Size and Service Outsourcing Level, with size as the variable that most explained variation of StPROFIT₂₀₀₁. Size positively affected profitability, while outsourcing had a negative effect on it. The other variables, representing the various operating practices, had no significant effect on the dependent variable to be selected by means of the stepwise method.

Table 3: Multiple regression for Profitability

Variables	Coefficient	t-test	p-value
(Constant)	0.050	2.012	0.044
LnStR ₂₀₀₁	0.206	7.964	<0.001
StT ₂₀₀₁	-0.131	-5.143	<0.001

The second regression, including dummy industry variables, and interactions of these dummies with the other independent variables explained 8.9 percent of Profitability variation. The variables that most contributed to the explanation are listed in Table 4. Note that the size variable affected industries 283 (forging, stamping, powder metallurgy and metal-treatment services) and 361 (manufacturing, furniture) differently, that is, with negative impact on industry 283 and positive for 361. In this case, for industry 283, a one-unit increase to variable LnStR₂₀₀₁ reduces Profitability by $-0.134 (=0.210-0.344)$ deviations from the industry, while in industry 361 a similar increase would cause Profitability to rise by $0.478 (=0.210+0.268)$ deviations. Likewise, the variable Age (StA) helped explaining Profitability change in industry 252 (Manufacturing, plastic goods) with its negative effect on firm Profitability.

Table 4: Multiple regression for Profitability with industry dummies and interaction terms

Variables	Coefficient	t-test	p-value
(Constant)	0.049	0.00	1.000
LnStR ₂₀₀₁	0.210	7.723	<0.001
LnStRa ₂₀₀₁ *D283	-0.344	-3.270	0.001
StT ₂₀₀₁	-0.128	-5.047	<0.001
StA*D252	-0.162	-2.591	0.010
LnStR ₂₀₀₁ *D361	0.268	2.406	0.016

The second model to be tested checked for the effect of production variables on variation of the revenue growth rate, represented by the variable RevenueGR.

The model explained 25 percent of the variation in RevenueGR. Table 5 shows that not only do the control variables explain this variation, but two other production variables helped the explanation as well. Note that while Size had a positive effect on Revenue Growth Rate, all other variables — Age, Service Outsourcing Level and ISO Certifications — had a negative and weaker effect on Revenue Growth Rate. Size remained the model's primary explanatory variable and also had the greatest impact on RevenueGR; meanwhile, the other two operating practice variables showed negative coefficients, indicating that they were associated with lower growth and have lower explanatory power.

Table 5: Multiple regression for Revenue Growth Rate

Variables	Coefficient	t-test	p-value
(Constant)	0.384	17.479	<.001
LnStR ₂₀₀₁	0.373	18.300	<0.001
StA ₂₀₀₁	-0.125	-6.350	<0.001
StT ₂₀₀₁	-0.075	-3.806	<0.001
ISO	-0.168	-3.407	0.001

The model with industry dummies and their interaction terms for the revenue growth rate variable explained 28.6 percent of RevenueGR variation. This is an indication that the operational practices had industry-dependent effects.

Table 6 displays these results and shows that the variables Size and Age remained the most important ones. Size had a positive effect on Revenue Growth Rate, while the effect of Age was negative. The size effect, though positive, was weaker for industry 296 (Manufacturing, other specific machinery and equipment), and the age effect was positive for industry 264

(Manufacturing, ceramic products), unlike the other industries studied here.

As for operating practice variables, we can see that inclusion of the ISO variable into the regression model in Table 5 was largely due to the influence of industry (Manufacturing, ceramic products). For this industry, ISO certification had a stronger negative effect on a firm's growth rate than in other industries. The effect of adopting quality practices appeared to be significant and positive for industry 292 (Manufacturing, general machinery and equipment), but negative for industry 181 (Garments tailoring). In both cases, however, despite statistically significant coefficients (due to the large number of observations) the practical significance of the results may be questioned, and it may be more accurate to interpret the results as absence of relevant relationships between quality practices and performance.

Table 6: Multiple Regression for Revenue Growth Rate with industry dummies and interaction terms

Variables	Coefficient	t-test	p-value
(Constant)	0.388	17.342	<0.001
LnStR ₂₀₀₁	0.404	19.553	<0.001
StA ₂₀₀₁	-0.153	-7.589	<0.001
StT ₂₀₀₁	-0.076	-3.899	<0.001
LnStR ₂₀₀₁ *D296	-0.320	-3.959	<0.001
ISO*D264	-0.655	-3.203	0.001
StA ₂₀₀₁ *D264	0.275	3.962	<0.001
ISO	-0.154	-3.117	0.002
Q*D292	0.052	2.544	0.011
Q*D181	-0.044	-2.385	0.017

FINDINGS AND LIMITATIONS

This study explored the broad SEADE database developed from PAEP surveys done in 1996 and 2001 to find relationships between the use and intensity of operating practices such as quality management, just in time, ISO certifications, outsourcing level and firm's financial performance. The operations management literature, with its theoretical and empirical studies, indicates the presence of a positive relationship between those practices and performance. Generally speaking, such relationships were not found in the sample of 1,200 São Paulo State companies in 14 manufacturing industries. That is to say, no evidence was found that the practices can drive superior performance, or even create competitive edge-generating competencies for organizations (KETOKIVI; SCHROEDER, 2004; HAYES; PISANO, 1996).

The only variable showing consistent relationships was outsourcing level, which showed a negative relationship with both profitability and growth. This finding leads to a reflection on the fad of outsourcing, which may not be producing the expected results and endure constant criticism (ROSSETI; CHOI, 2005) and empirical studies that have been equally unable to identify a direct tie between outsourcing and financial performance (JIANG; FRAZIER; PRATER 2006).

The remaining practices (quality management, just in time, ISO certifications) showed no significant effect, except relatively weakly and in certain specific industries. One possibility is associated with the findings of Powell (1995), who identified cultural and tacit elements in quality management as performance determinants, rather than the use of the techniques in and of themselves. The variables present in the PAEP survey did not allow exploring this aspect and this is a clear limitation.

Analyzing the industry-specific effects through dummy variables, some operating practices showed statistically significant effects. The presence of ISO certification had a negative influence on the growth rate of industry 264 (Manufacturing, ceramic products), which may indicate a growth advantage for non-ISO certified firms in the period at hand. This advantage may be completely temporary, and further analysis is needed to verify this point. The other operating variables inserted into the regression model for the revenue growth rate variable are also specific for certain

industries, such as quality for industries 292 (Manufacturing, general machinery and equipment) and 181 (Garments tailoring).

Size, used as a control variable, proved to have a positive relationship on both profitability and growth, confirming previous studies done with data from the United States and other countries (BRITO, 2006; BRITO; BRITO; VASCONCELOS, 2005).

It is also important to note several limitations of this study that may be addressed in future efforts. The first limitation, which is evident in a study such as this, concerns the use of a secondary database created for a purpose other than that of the research at hand. Venkatraman and Ramanujam (1986) also suggest using a primary data source to validate the information. Questions concerning the limited operationalization of constructs, discussed in several earlier points, have to do with this choice to use an existing database. On the other hand, the size and scope of the database made it appealing for this investigation.

Another limitation, as noted by March and Sutton (1997) concerns the instability of the performance advantage. This limitation is valid given that the impact of independent production variables on the output variables may be reduced over time, specially as it concerns comparisons with the competition. The competitive effect of a certain production practice will be greater for early adopters and followers will not extract the same competitive advantage as more pioneering firms;

Yet another limitation lies in the absence of a historical data series year-to-year. This prevents evaluating the time needed to adopt a certain practice and limits us to telling whether or not a firm had such a practice in place in 2001. A firm that adopted the practice earlier might be able to extract more benefits than a recent adopter. As a consequence of this limitation, it is important to point out that the study has only concerned itself with the presence or absence of operating practices; the quality of implementation and management of those practices was not taken into account.

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