Does Quality Management Improve Performance? A Longitudinal Multilevel Approach

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Abstract

The paper introduces a new approach to investigate the relationship between quality management and financial performance: the multilevel modeling. It offers unique advantages, like the measurement of variables and variances at each level and the recognition of the natural hierarchical structure of the data overlooked in traditional methods. A sample of firms acknowledged by the Brazilian National Quality Award (PNQ) had its financial performance over 20 years compared with a control group formed by companies from the same sectors. In total, 10,389 observations from 2,364 companies were used. The performance was separated into profitability and growth, and the results revealed a positive relationship between quality and performance only for profitability. The analysis of longitudinal data with the multilevel methods showed no evidence that this profitability improves over the time, suggesting the existence of a covariation link, rather than a causal link, between quality and profitability.

Introduction

The empirical support of a positive relationship between quality management and firm performance is still an interesting research topic due to the mixed results produced so far, the challenges of performance operationalization and the difficulty in obtaining large samples.

During the last two decades of the last century, quality management became part of the business life of most companies, being largely disseminated among the world's largest firms (COLE, 1998). Although the advantages of quality were widely publicized (DEMING, 1986, 1993; JURAN, 1964, 1989; FEIGENBAUM, 1956; CROSBY, 1979), the body of empirical research relating quality management and performance produced mixed results due to differences in operationalization of constructs, the level of performance analyzed and the associated analytical frameworks (KAYNAK, 2003). Adam Jr. et al. (1997) also found significant differences when comparing explanatory models relating quality improvement and performance between different regions of the world.

In several of the previous studies, financial performance was operationalized either as a single construct (ADAM JR., 1994; ADAMS; McQUENN; SEAWRIGHT, 1999; ITTNER; LARCKER, 1997; MOHRMAN et al., 1995; SILA, 2007) or as a composite construct (DAS et al., 2000; DOUGLAS; JUDGE, 2001; KAYNAK, 2003; NAIR, 2006; POWELL, 1995; WILSON; COLLIER, 2000). However, the impact of quality on profitability and growth might be different. Cho and Pucik (2005) found empirical evidence that, although quality has a direct impact on profitability, its influence on growth is mediated by firm innovativeness. Benner and Tushman (2003) offered a possible theoretical justification for different impacts of quality management in different aspects of performance, or contexts using the concepts of exploration and exploitation (MARCH, 1991). In the present study, we simultaneously and independently explore two dimensions of financial performance: profitability and growth. Other original characteristic of the research is the exploration of the Brazilian economic environment, well known to be highly dynamic.

Another gap found in empirical studies conducted so far, with few exceptions (YORK; MIREE, 2004), is the lack of longitudinal data analyses. Without them, a crucial aspect of quality and performance investigations remains unanswered: is there a causal link between quality and performance, or are firms with superior performance more predisposed to adopting quality management models due to a different cause or to pursuit of a different benefit? These causes or benefits may include the influence of the bandwagon effect on the choice to manage quality and the pursuit of external recognition and legitimacy (STAW; EPSEIN, 2000; ZBARACKI, 1998; WESTPHAL; GULATI; SHORTELL, 1997).

In this study, data on financial performance of effective adopters of quality

management were evaluated on a long-term basis (10 years), including the "pre-quality" period, when the principles, practices and techniques associated with quality management are being implemented. This longitudinal data analysis permits to distinguish if occasional associations between quality and financial performance demonstrate a causal relationship (quality is a way to improve financial success effect on financial performance) or just a covariation link (better performing companies may be more likely to adopt quality management).

In a pioneering effort for this type of study, data analysis used hierarchical linear modeling, also known as multilevel analysis. Multilevel methods are extensively used in other fields like Education, Biology and some areas of Sociology, but their use in business administration has still been very limited. Their basic advantage is to recognize in the model the natural hierarchic existing in the data. The most traditional application is in Education where students are grouped in classes that in their turn are grouped in schools. The model recognizes this structure and allows one to identify separately the effects of student, class, and school variables on student performance. This hierarchic of data represents a dependency between observations that is not considered in traditional regression analysis. The assumption of independency between observations is violated in most studies that use traditional methods. Besides solving this problem, the multilevel methods can be used to treat longitudinal data properly representing the phenomena.

Literature Review

Quality theory

The roots of the quality movement is usually associated with the activities of a few pioneers viewed as the founders of this field of study. This group includes Juran (1964), Feigenbaum (1956), Ishikawa (1985), Crosby (1979) and, above all, William E. Deming (1986, 1993), whose work has had the most impact on the establishment and evolution of the quality movement.

Deming's (1986) chain-reaction concept, originally introduced in Japan in 1950, argues – contrary to common wisdom at the time – that improved quality would directly impact increased productivity and improved profitability. The author's main emphasis is on improved product and service quality through reduced project and execution uncertainty and variation. This was the first "quality model".

Since then, a prolific body of literature emerged on topics ranging from a discussion of the meaning of quality (REEVES; BEDNAR, 1994) to the integrative perspective of quality management as a theory (DEAN JR.; BOWEN, 1994; ANDERSON; RUNGTUSANATHAM; SCHROEDER, 1994; HANDFIELD; MELNYK, 1998). Yong and Wilkinson (2002) offer an historical review of the quality management literature, and Cole (1998) provides a more critical view of this evolution.

Powell (1995) interprets the effect of quality management on performance through the lens of the resource-based view (RBV) of the firm. RBV starts with the notion that resource heterogeneity is the main reason for the performance heterogeneity across firms, and it views resources as the most appropriate unit of analysis (BARNEY, 1986; PETERAF, 1993; WERNERFELT, 1984). For a resource to be a source of competitive advantage, it must be only imperfectly imitable or substitutable by firm's competitors. Dierickx and Cool (1989) discuss several resource characteristics that prevent or inhibit imitability. Powell (1995) argues that quality management exhibits several of these characteristics. Examples include time compression diseconomies, as quality management takes time to be developed and firms that attempt to shortcut this process will have difficulties or higher costs, and social complexity, because quality management has strong ties to company culture and employee involvement. Connectedness of resources exists because, for quality management to be

effective, it needs the interconnection with other organizational features such as leadership style and culture. Thus, quality relevance to firm performance goes beyond a simple improvement effect, it can be a source of sustained competitive advantage.

Some researchers, however, are more skeptical about the role of quality management in firm performance. Reger et al. (1994) discuss difficulties implementing quality management, due mainly to employees' resistance to change. Hackman and Wageman (1995) compared the actual practice of Total Quality Management (TQM) in the U.S. with the original concepts set forth by Deming, Juran and Ishikawa, finding that, although there is reasonable overall agreement, some areas present divergences. For example, in practices, there is less intense use of scientific methods to monitor performance and to identify points for improvement. Another area of divergence is the reward system with an emphasis on individual, rather than group, incentives. There is also the issue of TQM distinctiveness against other organizational initiatives (Hackman; Wageman, 1995). Thus, although there may be theoretical reasons to believe that quality management will be related to firm performance, the actual practice of quality management diverges significantly from the theoretical ideal. Hackman and Wageman (1995) identify three trends that together point to a gloomy future for TQM and will cause the movement to lose its prominence in the future. The first trend is that rhetoric is winning over substance. As the authors put it: "Science is fading, the slogans are staying, and the implications are worrisome" (HACKMAN; WAGEMAN, 1995, p. 338). This is supported by the work of Zbaracki (1998), who, using an institutional theory perspective, proposed a distinction between technical TQM and rhetorical TQM, which has mainly a symbolic value. The second trend is that a number of other interventions are being herded under the TQM banner, whether they are theoretically associated with quality management or not. Thus, TQM may be losing its unique identity. The third trend is that research has not provided a corrective function tor TQM, since it mostly consists of anecdotal case studies and simplistic before-and-after evaluations.

Westphal, Gulati and Shortell (1997) demonstrated the quality management adoption is sometimes driven by pressures to conform, rather than technical exigencies. The success of initial quality management adopters fuel institutional isomorphic pressures on competitors, which end up adopting quality in a more normative way. While the initial adopters may enjoy technical benefits, the late adopters seek and obtain only legitimacy benefits. Thus, comparison of benefits between early and late adopters of quality management may be confounded.

Staw and Epstein (2000) analyzed the impact of the use of the so-called "popular management techniques", including quality management. According to the researchers, quality management adopters do not show above average profitability, but are even more admired and perceived to be more innovative, and their managers secure higher compensation than their peers in other firms. This split between reality and image supports the institutional theory, with obvious implications for the agency theory. Proliferation of "popular management techniques" could be explained by the bandwagon effect.

Benner and Tushman (2003) review a number of reasons for the adoption of quality management to be ineffective. Firms that adopt quality management may fail to fully implement the associated efficiency-generating practices. There may be implementation problems caused by not giving it sufficient time to mature, or by implementing it by force. The effects of quality may be contingent on the context where they are applied. Adoption might be caused by a bandwagon effect, as described above. Quality management may hinder adaptation outside of existing trajectories, as core capabilities may become core rigidities or competency traps in rapidly changing environments (LEONARD-BARTON, 1992).

Empirical researches

The key moment of academic research on the impact of quality on financial performance was the seminal work of Powell (1995), published in the *Strategic Management Journal* and with important implications for the operations and strategy areas. In his empirical research, Powell showed that characteristics most often associated with quality management – process improvement, benchmarking, quality training – do not produce competitive advantages, unlike certain tacit, behavioral and inimitable characteristics – organizational culture, empowerment and a committed leadership. According to Powell, these results were consistent with RBV (DIERICKX; COOL, 1989; BARNEY, 1986; PETERAF, 1993). The article was also the first to challenge the holistic view of quality, as in the study three of twelve practices associated with quality management were significantly associated with global performance, which suggests that firms could capture the benefits extolled by quality management without necessarily embracing its entire "ideology".

Hendricks and Singhal published studies (1996, 1997, 2001a) proving positive correlations between effective application of quality management and firm performance, showing evidence of a positive reaction of the stock market to announcements of quality prizes won, manifested as abnormal returns on the day of such announcements; superior long-term growth of quality award winners in terms of indicators such as sales, operating profits, employment level and assets. In a different study, Hendricks and Singhal (2001b) focused on the contribution of quality management to maximization of the wealth of shareholders in publicly traded corporations, tracking the long-term evolution of the market value of those firms against a control group. The results show the absence of significant differences in firm market value gains during the TQM-implementation period; after implementation, however, award-winning firms showed 38% to 46% better performance, depending on the scenario.

Chenhall (1997) found support for the hypothesis that relates superior financial performance, represented by composite indicators including either profitability and growth, with the joint implementation of quality management programs and manufacturing performance metrics. Easton and Jarrell (1998) find positive relationships between adoption of quality management and improved results in terms of growth, profitability and market value. Wilson and Collier (2000) studied the causal link between the various criteria that formed the Malcolm Baldrige National Quality Award's model in 1995; they found evidence of positive effects from the Process Management and Information and Analysis criteria on aggregate financial performance. The study also shows that the other criteria had no direct influence on financial performance, but did have an indirect impact through their effect on Process Management and Information and Analysis.

Das et al. (2000) used a structural equation model to relate quality practices to customer satisfaction and firm performance. Firm performance was a latent variable, which included indicators of both profitability and growth. They found that high involvement practices had a direct and positive effect on firm performance and that quality management practices positively influenced customer satisfaction, which, in its turn, influenced firm performance.

Fynes and Voss (2001) concluded that customer satisfaction receives a positive impact from quality and design practices. But no significant effect of customer satisfaction on aggregate financial performance was found. Kaynak (2003) developed a complex structural model to represent the relationships between several TQM practices. She found a positive relationship between the latent variable called quality performance and financial and market performance. The latter was also a latent variable that included indicators of profitability, growth and market share. Cho and Pucik (2005) tested a theoretical model using structural equations to find evidence of a relationship between quality and profitability. They were unable, however, to observe the effect of quality on growth, except where innovation was present as a mediating effect.

Adam et al. (1997) explored the relationship between several characteristics of TQM and financial performance, operationalized as growth and profitability. Their analysis was done with stepwise regressions and, although the R^2s were low (below 0.1) and practical significance might be questionable, all regressions were statistically significant and some of the TQM characteristics related significantly to both profitability and growth.

Nair (2006) was responsible for the first meta-analysis study on the impact of quality on performance, using data from 23 previous studies. In terms of aggregate financial performance, the results show positive effects from leadership, people management, process management, and customer focus practices. No positive effects of product design, product management, suppliers management and quality data analysis were found.

However, in addition to Powell (1995), other researchers have found conflicting results. Mohrman et al. (1995) investigated the impact of improvement initiatives on firm performance and failed to show a positive relationship between adoption of quality management and profitability. The findings of Ittner and Larcker (1997) also failed to support the view that process management contributes to the firm's financial performance, but did find that certain techniques made a positive impact, while others had practically no effect; in particular, long-term partnerships with suppliers and customers were related with improved profitability, while training, quality- and teamwork-based compensation systems, and organizational commitment to improvement were not related with profitability gains.

Adams, McQuenn and Seawright (1999) revisited and expanded the work of Hendricks and Singhal (1996) and, based on their findings, discussed a series of methodological reasons to take the original findings of Hendricks and Singhal (1996) with caution. York and Miree (2004) showed that winners of the Malcolm Baldrige National Quality Award and of state quality awards in the United States had better financial results, including profitability, than the members of a control group, both before and after the award, supporting the notion of co-variance, rather than a causal link, between superior performance and quality management adoption.

Several other studies used a definition of performance that did not include financial measurements, like customer satisfaction, inventory turnover or productivity. Logically, these performance elements should improve financial performance, but firm performance was not actually measured. The majority of these studies found that quality management practices had a positive effect on these performance elements (ANDERSON et al., 1995; CHOI; EBOCH, 1998; DOW; SAMSON; FORD, 1999; FLYNN; SCHROEDER; SAKAKIBARA, 1995; RUNGTUSANATHAM et al., 1998; SAMSON; TERZIOVKI, 1999).

The knowledge produced by empirical studies on the impact of quality management on financial performance shows that no conclusive results found. A positive relationship is present in a relevant share of studies, but, on the other hand, important researches were unable to demonstrate such a relationship.

Many of the previous studies did not separate the effects of quality management on profitability and growth, taking some composite performance measure. This paper did this separation and found different relationships between quality and each of these performance dimensions. In addition, most of these studies did not use longitudinal data analyses, preventing the formation of a clear view about the type of relationship between quality and financial performance: causation or covariation? Taken together, these aspects call for further investigation, specially exploring different settings.

Methodology

Constructs

In empirical studies attempting to relate quality management and performance, the quality construct is usually operationalized by identifying the presence of management practices

through questionnaires and/or interviews (POWELL, 1995; EASTON; JARRELL, 2001; DOUGLAS; JUDGE, 2001), or by firm acknowledgement in the form of quality awards (HENDRICKS; SINGHAL, 1997, 2001a, 2001b; ADAMS; McQUEEN; SEAWRIGHT, 1999).

This study represents effective adoption of quality management with public acknowledgement by *Fundação Nacional da Qualidade* – FNQ (National Quality Foundation). This acknowledgement is limited to winners or finalists of *Prêmio Nacional da Qualidade* – PNQ (National Quality Award), the Brazilian counterpart to the Malcolm Baldrige National Quality Award, which assures high rigor, insofar as only organizations with highly effective implementation of quality management have been selected. The studied period comprehends the entire history of PNQ, including, therefore, firms acknowledged since the first cycle, in 1992, to the latest available at the time of the study – 2006. In this period, Fundação Nacional da Qualidade acknowledged 61 organizations, 37 of which as finalists and 24 as award winners. For the sake of simplicity, this article will hereinafter use the term "finalist" to designate both types of acknowledgement.

Firms for which performance data were unavailable from database were excluded from this set, as were members of the financial sector, because of the banks' peculiar financial performance metrics.

Use of firm performance as a dependent variable in empirical studies is increasingly frequent in the operations and strategy areas. Concern with proper use of the variable is reflected in the work of Venkatraman and Ramanujam (1986), who discuss the benefits, limitations and methodological precautions relevant to several strategies for using organizational performance in empirical research. March and Sutton (1997) discuss difficulties using performance as a dependent variable, especially those that relate the causal structure that connects the relevant organizational characteristics with performance. Glick, Washburn and Miller (2005), in turn, carry on with the conceptual discussion of Venkatraman and Ramanujam (1986), exploring the concept that performance can be treated as a one-dimension construct, a multi-dimension construct or a set of several constructs. This study adopts the third approach, working with indicators of firm growth and profitability.

The profitability indicator was calculated as the ratio between operating profit and net sales. Operating profit, was selected because it excludes financial operations, thereby reflecting the firm's ability to generate profits from its core activities. Growth has been operationalized as the percentage growth of net sales. Firm size, used in the multilevel modeling as a firm level variable, was operationalized as the average net sales computed based on annual figures for the period over which each firm's performance was ascertained. All monetary observations were recorded in Brazilian currency at the time and subsequently deflated to January 1st, 2007, according to the IPC-A inflation index as published by IBGE (Brazilian Institute of Geography and Statistics).

This study tracked the performance of each PNQ finalist over a period of 10 years. For each firm, we formed a scenario where the performance of other firms in the same industry was also tracked for the same period of time. Due the analysis strategy used , the 10-year period was divided into two segments; the split was based on the firm acknowledgement as a PNQ finalist as evidence that principles and techniques associated with quality management have been effectively implemented. The year of acknowledgement is identified as year 0. The five preceding years comprise the implementation period and are identified as years -1, -2, -3, -4 and -5. The five-years period beginning with year 0 represents the post-implementation period and is represented as 0, +1, +2, +3 and +4.

This view of long-term performance finds strong support in quality literature (DEMING, 1986, 1993; JURAN, 1964; GARVIN, 1988; ANDERSON; RUNGTUSANATHAM; SCHROEDER, 1994; HENDRICKS; SINGHAL, 1997), which

usually characterizes the implementation stage of quality programs as a period of heavy investment and early results, and the post-implementation stage as a period of consolidated gains and superior performance.

Data

Data on financial performance of Brazilian firms were obtained from the *Balanço Anual* database, published by *Gazeta Mercantil* newspaper. Balanço Anual is updated annually since 1977 with accounting results of over 10,000 firms in several economic sectors. For the purposes of this study, the data comprehend the 1986-2005 period, corresponding to the 1987-2006 issues of Balanço Anual. Industry categorization abides by Gazeta Mercantil's rules, with three hierarchy levels. The level used in this study is the most detailed – level 3.

To eliminate outliers, detailed evaluation was applied, in each scenario and year, to all observations more than three standard deviations from mean. Next, to isolate sector effect, we calculated the indicators $PROFIT_{q,t}$ and $GROWTH_{q,t}$. To illustrate the calculus with profitability, for each year *t* the profitability *P* of each firm *q* was related with the sector's average profitability and the standard deviation of the sector's firms' profitability as follows:

$$PROFIT_{q,t} = \frac{P_{q,t} - \overline{P}_{sector,t}}{s_{sector,t}} \quad [1]$$

The same transformation was used for the indicators $GROWTH_{q,t}$ and SIZE. In the case of the latter, because of the typically non-normal distribution of firm size, a log transformation was used on net sales figures in advance.

Table 1 provides information on the original data and the resulting sample after outliers elimination.

Table 1 – Original observations and observations used in the analysis

	Original data				Data used in the analysis			
	PNQ		Sector		PNQ		Sector	
	Data	Firms	Data	Firms	Data	Firms	Data	Firms
Profitability	217	31	5,466	1,231	217	31	5,137	1,188
Growth	236	32	5,173	1,153	228	32	4,807	1,113

Multilevel modeling

Multilevel methods are extensively used in other fields of research like Education, Biology and some areas of Sociology, but their use in business or economics has still been very limited (HOFMANN, 1997). Some recent papers in strategic management literature started to demonstrate its potential (MISANGYI et al., 2006; SHORT et al., 2007). Their basic advantage is to recognize in the model the natural hierarchic existing in the data, overcoming a basic shortcoming of regression and allowing a more encompassing use of contextual variables (BICKEL, 2007; HOX, 2002). The most traditional application is in Education where students are grouped in classes which in their turn are grouped in schools. The model recognizes this structure and allows one to identify separately the effects of student, class, and school variables on student performance. In business, we have a similar structure. Firms, for example are grouped within industries, which, in their turn, could be grouped within countries. This hierarchical nature of data represents a dependency between observations that is not considered in traditional regression analysis. The assumption of independency between observations is violated in most studies that use traditional methods. Besides solving this basic problem, the multilevel methods can be used to treat longitudinal data properly representing the phenomena (SINGER; WILLET, 2002). In this case, as used in this paper, the different performance observations of the same company constitute the first level. All these observations belong to the same firm that is the second level. In this way, it is possible

to identify variables that affect the lowest level, like the year where the observation is taken, and variables that affect the second level, the firm. The fact that the firm became a finalist in the award contest and its average size are variables defined at firm level, and their specific influence on performance can be modeled.

The analysis was developed in two stages using multilevel models. In the first stage, a single linear growth curve was modeled for both profitability and growth rate as a function of time. Each firm was represented by a line with two regression parameters: the intercept and the slope. The intercept corresponds to the estimated performance level (profit or growth rate) at the year zero. The slope corresponds to the average rate of change of performance throughout the whole period. Both intercepts and slopes were modeled to be random variables and each firm's parameters are then a realization of these random variables. Intercepts and slopes vary from firm to firm. The analysis focused on identifying whether the intercepts and slopes of firms that were finalists in the quality award were significantly different from the others. The curve A in Figure 1 represents this stage.

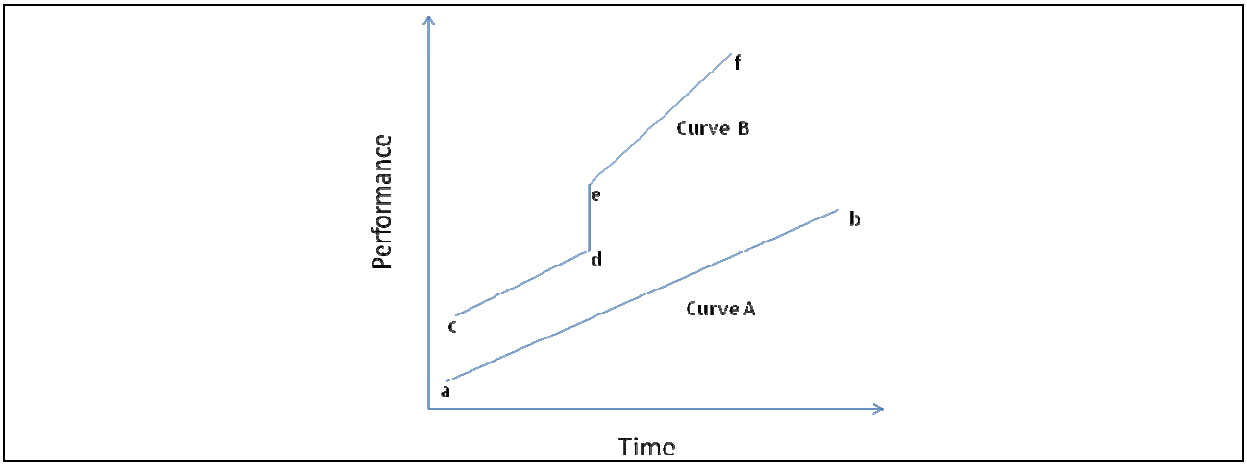

Figure 1 – Multilevel models concept

In the second stage, a more complex growth model that split the period of analysis into two segments was used. Each firm was represented by two linear segments one before the award contest and another after. Each firm was then represented by four parameters: the intercept, the baseline slope, the increment in intercept at the year the quality award occurred and the additional slope after the award. Curve B, in Figure 1, represents this modeling stage.

More formally, the first stage is represented by the following set of multilevel equations, in the case of the performance measured as profitability.

Level 1

$$PROFIT = \beta_0 + \beta_1 [YEAR] + r \quad [2]$$

Level 2

$$\beta_0 = \gamma_{00} + \gamma_{01}[SIZE] + \gamma_{02}[FINALIST] + u_0 \quad [3]$$

$$\beta_1 = \gamma_{10} + \gamma_{11}[SIZE] + \gamma_{12}[FINALIST] + u_1 \quad [4]$$

The level one equation represents each firm profitability as a function of time, being the equivalent of curve A in Figure 1. Both β_0 and β_1 are different for each firm as shown in the level 2 equations. The term *r* represents the error term recognizing that not all profitability observations match perfectly this equation. The larger the variance associated to *r*, σ_r, the larger this misfit. The level 2 equations show the variability of β_0 and β_1 within the population of firms and how these figures are related to firm variables. The coefficients γ_{01}, γ_{02}, γ_{11}, and γ_{12} can be interpreted similarly to regression coefficients. For example, γ_{02} represents the effect of being a finalist (a dummy variable that is 1 when the firm was a

finalist) on the intercept β_0 (or the reference performance at year 0) of firms. A positive coefficient would mean that firms that were finalists had a better overall mean performance by that amount. The coefficient γ_{12} represents the effect of being a finalist in the slope of change of performance. A positive value for this coefficient would indicate that performance was increasing steadily during the observed period. The error terms u_0 and u_1 represent the unexplained variance of intercept and slope respectively. The corresponding residual variances are σ_{u0} and σ_{u1} and both are estimated in the model. A simpler model, without these explanatory variables at level 2, can be run to estimate the total variances σ_{u0} and σ_{u1}. A similar model will be built for growth instead of profitability as the dependent variable.

The second stage of analysis will use a more complex model at level 1, corresponding to the equations:

Level 1

$$PROFIT = \beta_0 + \beta_1 [YEAR] + \beta_2 [INDICAT] + \beta_3 [YEAR\_AFTER] + r \quad [5]$$

Level 2

$$\beta_0 = \gamma_{00} + \gamma_{01}[SIZE] + \gamma_{02}[FINALIST] + u_0 \quad [6]$$

$$\beta_1 = \gamma_{10} + \gamma_{11}[SIZE] + \gamma_{12}[FINALIST] + u_2 \quad [7]$$

$$\beta_2 = \gamma_{20} \quad [8]$$

$$\beta_3 = \gamma_{30} \quad [9]$$

The variable [INDICAT] was construed to be one at the year a firm become a finalist in the quality award contest and remain one thereafter. All other values are zero. The coefficient β_1 thus represents change in intercept at the moment the company becomes a finalist and represents the segment (*d-e*) in curve B of Figure 1. The coefficient β_2 represents the baseline rate of change of performance across time. A positive coefficient indicates a steady increase in performance and a negative a steady decrease. A non-significant coefficient means one cannot say whether performance in increasing or decreasing. The variable [YEAR_AFTER] was construed as being zero for all years before year zero (the year the firms became finalists for the quality award). For the companies that became finalists, this variable took the values (1, 2, 3, ...) for each year after the award. For the control companies that did not participate in the award the values remained at zero. With this construction, the coefficient β_3 represents the change in slope after the company became the award finalist, or the change in slope from the segment *c-d* to the segment *e-f* in curve B, Figure 1. A positive coefficient means that the rate of change in performance became better and a negative that the rate of change of performance with time was negatively affected by the fact of becoming a finalist. The intercept and baseline slope (β_0 and β_2) are modeled as random variable and assume different values for each firm as in stage 1. The change in intercept and slope due to becoming a finalist (β_0 and β_2) are modeled as fixed, assuming the same value for all finalists. Treating them as random variables would be problematic due to limited number of observations.

In this research a hierarchical linear model was developed and the HLM 6.06 software was used to solve the system. Models of increasing complexity were developed and the comparison between each model is useful in assessing the explanatory power of each added variable. The basic model is also called an empty model, has no explanatory variables and is equivalent to a variance components analysis. The notation follows the conventions used by the software developers (RAUDENBUSH; BRYK, 2002).

Results and Discussion

Profitability

The results of the analysis of profitability are shown in Table 2. As indicated before the analysis was developed in two stages analyzing two models in each stage, so four models are compared in Table 2.

Table 2 – Multilevel models for profitability

Dependent variable: profitability		Stage 1 - one segment		Stage 2 - two segments	
Variable	Description	Empty model	Explanat. variables	Empty model	Explanat. variables
β_0 , γ_{00}	Basic performance level	-0.0370	-0.0522**	-0.0225	-0.0347
γ_{01}	Effect of size on basic performance level		0.0686**		0.0701**
γ_{02}	Effect of becoming a finalist on basic performance level		0.2385***		0.2849***
β_1, γ_{10}	Baseline performance slope	-0.0016	-0.0055	0.0042	0.0015
γ_{11}	Effect of size on performance slope		0.0181**		0.0186**
γ_{12}	Effect of becoming a finalist on performance slope		0.0073		0.0197
β_2, γ_{20}	Increment in basic performance by becoming a finalist			0.0498	-0.1465
β_3, γ_{30}	Additional effect on baseline slope by becoming a finalist			-0.0198	-0.0234
	Correlation between basic performance and slope	0.2670	0.2600	0.2680	0.2620
σ_r	Variance at level one - between observations	0.4328	0.4326	0.4326	0.4324
σ_{u0}	Variance at level two - between firms' basic performance	0.5014***	0.4986***	0.5019***	0.4995***
σ_{u1}	Variance at level two - between firms' slope	0.0194***	0.0191***	0.0195***	0.0191***

All tests two-sided *** p-value better than 0.01 ** p-value better than 0.05 * p-value better than 0.10

The first model, called empty model, in stage 1, is equivalent to the equations [2], [3], and [4] without the variables [SIZE] and [FINALIST] in the second level. It simply depicts profitability as a linear function of time for all firms. The intercept and slope of this linear relationship are the variables β_0 and β_1. Each firm has a different value for these intercept and slopes and firms are represented by a family of linear regressions and shown in Figure 2 (a random sample of all firms analyzed). As all variables have been normalized the mean values of these intercepts and slopes should be close to zero and this is what resulted from the model with the expected values of β_0 and β_1 being non-significant and very close to zero. The random part of this model is more interesting and shown in the bottom of Table 2 where the estimated variances are shown. The variance between firms, σ_{u0}, was statistically significant meaning that different firms exhibit different levels of profitability. The relative size of this variance when compared to the variance at level one also demonstrates its practical significance. This supports the line of research in strategic management concerning variance decomposition of performance (HAWAWINI; SUBRAMANIAN; VERDIN, 2003; McGAHAN; PORTER, 1997; RUMELT, 1991) which states this variability between firms to be the most relevant source of variability of performance. This empirical finding also gives empirical relevance to the resource-based view of strategy that focuses on explaining these differences as caused by resource heterogeneity between firms (BARNEY, 1991; PETERAF, 1993; WERNERFELT, 1984). The variance associated with the slope, σ_{u1}, was also statistically significant, meaning that firms also differ in the fact that some are improving while other might be deteriorating their profitability across time. Finally the low correlation of 0.267 between intercept and slope indicates that a higher level of performance is not clearly associated with the fact that this profitability will be increasing.

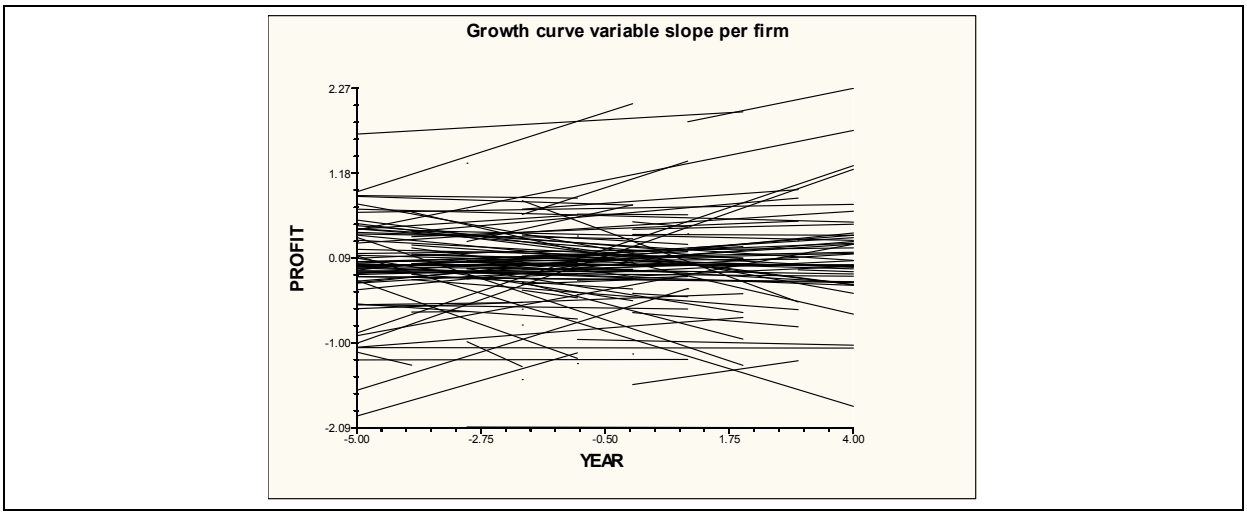

Figure 2 – A sample of profitability regressions

The second model completes stage 1 introducing two explanatory variables for both the intercept and slope of each firm. This model is exactly the one represented by equations [2] to [4]. Size showed a positive and statistically significant impact in both intercept and slope. This shows that larger firms exhibit higher profitability in average (the effect on the intercept - γ_{01}) and tend to increase this level of performance more than smaller firms (the effect on the slope - γ_{11}). This could be possibly be explained by economies of scale and scope or market power since size was taken as a relative measure (SCHERER; ROSS, 1990). Being a finalist was associated with a higher level of base profitability by the positive and statistically significant coefficient γ_{02}. However, the fact the coefficient γ_{12} was not statistically significant only allows one to say that firms that were finalists had a better average profitability and it is not possible to state that their profitability improved differently from all other firms. This casts doubts about the causal relationship between the quality initiative that led to the award and profitability. Since no difference in the rate of improvement could be detected it might well be that firms that became finalists simply had a better level of profitability at the start.

The second stage of analysis gives further support to this interpretation. Both the increment in the level of average profitability (β_2) and in the slope (β_3) were not significant and the latter was negative.

Growth

The analysis of annual growth rate as dependent variable is detailed in Table 3, following the same structure. The empty model indicates significant variability between firms (σ_{u0}) and significant variability between the slopes or rates of change of growth rates between firms (σ_{u1}). The variance at level one, however, is orders of magnitude higher than the variance between firms indicating that growth rates are more subject to a random element as indicated in specific econometric research on this subject (GEROSKI; MACHIN; WALTERS, 1997). The model with explanatory variables showed that size has a positive impact on the basic level of growth rate as the coefficients γ_{01} (in both stage 1 and 2 models) were positive and statistically significant. Size, however, did not show a direct effect in the rate of change of the growth rate since the coefficients γ_{11} did not reach statistical significance. There is some indication that larger firms also improve their growth rates by the high correlation between intercept and slope and the fact that coefficients in both models were positive. Being a finalist, in general, showed no positive effect on growth rates. Most coefficients were not statistically significant. In the case of stage 1 model the coefficient reached marginal significance but was negative indicating that firms that were finalists tended to decrease their growth rate during

the period. This negative impact of becoming a finalist is also suggested by the negative values of the coefficients γ_{02}, γ_{12}, β_2, and β_3 for all models. In summary, there is no evidence that firms that became finalists in the quality award are associated with different growth rates than other firms. In fact, the data suggest that finalists had a smaller growth rate to start and no improvement can be seen.

Table 3 – Multilevel models for growth

Dependent variable: annual growth rate		Stage 1 - one segment		Stage 2 - two segments	
Variable	Description	Empty model	Explanat. variables	Empty model	Explanat. variables
β_0 , γ_{00}	Basic performance level	-0.0004	-0.0239	0.0006	-0.0160
γ_{01}	Effect of size on basic performance level		0.1091***		0.1096***
γ_{02}	Effect of becoming a finalist on basic performance level		-0.1013*		-0.0921
β_1, γ_{10}	Baseline performance slope	-0.0001	0.0018	0.0002	0.0046
γ_{11}	Effect of size on performance slope		-0.0089		-0.0088
γ_{12}	Effect of becoming a finalist on performance slope		-0.0082		-0.0058
β_2, γ_{20}	Increment in basic performance by becoming a finalist			-0.0105	-0.0281
β_3, γ_{30}	Additional effect on baseline slope by becoming a finalist			-0.0008	-0.0080
	Correlation between basic performance and slope	0.9210	0.9470	0.9220	0.9490
σ_r	Variance at level one - between observations	0.9386	0.9296	0.9387	0.9297
σ_{u0}	Variance at level two - between firms' basic performance	0.0072**	0.0069*	0.0074**	0.0071*
σ_{u1}	Variance at level two - between firms' slope	0.0021***	0.0018***	0.0022***	0.0019***

All tests two-sided *** p-value better than 0.01 ** p-value better than 0.05 * p-value better than 0.10

Conclusions

The study investigated the presence of relationships between effective adoption of quality management and financial performance, with the Brazilian economic environment as a backdrop. The findings indicate the presence of a positive relationship between quality and profitability, but not between quality and growth. Use of longitudinal data analysis indicates that National Quality Award winners showed no profitability gains and that, therefore, the positive relationship between quality and productivity already existed at the start. This indicates a covariance relationship between quality and productivity.

This finding diverges from quality management theory, which argues for a causal link between quality and profitability. In addition to the pursuit of external recognition and legitimacy, and the influence of the bandwagon effect, discussed earlier, other possible explanations may be ventured. One can be found in Benner and Tushman (2003): might users of management models that focus on quality be losing the ability to generate radical innovation and remain agile and flexible because of the model's "weight" and, therefore, losing the ability to improve profitability? Another possible reason involves the study of quality theory and the empirical results under resource-based view. A large share of quality concepts involves techniques, standards, methodologies, practices and tools that were essentially developed for dissemination across firms. This appears to run against several aspects concerned with securing competitive advantages, as proposed by RBV. For example, it is reasonable to assume that such techniques and tools associated with quality can be easily obtained from the market of strategic factors as explained by Barney (1986), and therefore do not favor the heterogeneity competitive differentiation required for competitive differentiation (WERNERFELT, 1984). In addition to being tradable, the nature of these quality-related factors enable easy transfer and imitation and, consequently, they are not scarce (DIERICKX; COOL, 1989; BARNEY, 1991; PETERAF, 1993). An aggregate analysis of these aspects seems to show an environment that does not foster obtaining competitive advantages. A third

possible explanation that appears to arise from the theory and empirical findings is a possible emphasis on a tools-oriented approach in quality management implementation, with excessive emphasis on practices, methods and procedures to the loss of tacit and behavioral characteristics that are more closely connected with obtaining competitive advantage (POWELL, 1995).

The study also brings important methodological contributions to empirical studies on the impact of quality management on performance. The separation of financial performance into profitability and growth is one of them, and it was possible to show that different relationships exist between quality and these two dimensions of financial performance. The use of a new data-analysis approach based on multilevel methods may, in turn, be regarded as the paper's main contribution. The use of a more robust modeling, with clear advantages over traditional methods, enabled testing four longitudinal analysis models for each dimension of financial performance.

This study also has limitations, most of which have to do with the sample. Ours is a non-probabilistic sample and, therefore, any attempt at generalization must be conducted with extreme caution. The sample size is also a limitation, although it is inherent to certain aspects of the study, such as its rigor – use of PNQ acknowledgement as proxy for effective adoption of quality management – and the late start of national quality awards, producing a reduced number of acknowledged firms so far.

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