



The effects of Six Sigma on corporate performance: An empirical investigation

Scott M. Shafer^{a,*}, Sara B. Moeller^{b,1}

^a Wake Forest University, Schools of Business, Winston-Salem, NC 27109, United States

^b University of Pittsburgh, Katz Graduate School of Business and College of Business Administration, Pittsburgh, PA 15260, United States

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ABSTRACT

The purpose of this study is to investigate the impact of adopting Six Sigma on corporate performance. Although there is a fairly large and growing body of anecdotal evidence associated with the benefits of implementing Six Sigma, there is very little systematic and rigorous research investigating these benefits. This research extends previous research in several important ways including utilizing a sample of 84 Six Sigma firms that represent a wide variety of industries and firm characteristics, utilizing rigorously constructed control groups to ensure the validity of our comparisons and conclusions, and investigating the impact of adopting Six Sigma on corporate performance over a ten year period. To carry out this investigation, the event study methodology is employed. The ten year period consists of three years prior to Six Sigma implementation, the event year corresponding to the year Six Sigma is adopted, and six years post Six Sigma implementation. To assess the impact of adopting Six Sigma on corporate performance we utilize commonly used measures including Operating Income/Total Assets (OI/A), Operating Income/Sales (OI/S), Operating Income/Number of Employees (OI/E), Sales/Assets (S/A), and Sales/Number of Employees (S/E). The sample Six Sigma firms are compared to different benchmarks including the overall industry performance and to the performance of carefully selected portfolios of control firms. The results of the study indicate that adopting Six Sigma positively impacts organizational performance primarily through the efficiency with which employees are deployed. More specifically, enhanced employee productivity results were observed in both static analyses that assessed the performance of the sample Six Sigma firms relative to their control groups at discrete points in time and dynamic analyses of the Six Sigma firms' rate of improvement relative to the rate of improvement of their control groups. Benefits in terms of improved asset efficiency were not observed. Finally, there was no evidence that Six Sigma negatively impacts corporate performance.

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1. Introduction

The Six Sigma methodology was created by Motorola in the mid 1980s. Over time it has evolved into a comprehensive approach for improving business performance. Key elements of the Six Sigma approach include a clear focus on the customers' needs, the use of performance metrics, a focus on improving business processes often through the reduction of inherent variation in the processes, clearly defined process improvement specialist roles, the use of data-driven and highly structured problem solving methodologies, and ultimately the generation of tangible business results (Hahn et al., 1999; Linderman et al., 2003; Schroeder et al., 2008). Pande et al. (2000, p. xi) provide a representative definition of Six Sigma as:

A comprehensive and flexible system for achieving, sustaining, and maximizing business success. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes.

Six Sigma is a particularly timely topic and appears to be gaining momentum in practice (Linderman et al., 2003; Schroeder et al., 2008). Perhaps one factor driving the current popularity of Six Sigma is the growing body of anecdotal evidence touting the benefits high profile organizations have reported from their Six Sigma initiatives. For example, in the three years ending in 2001, GE estimated that it saved \$8 billion as a result of its Six Sigma initiatives (Arndt, 2002). In the following year, GE budgeted \$600 million for Six Sigma projects and targeted an additional \$2.5 billion in savings. As another example, Bank of America claimed benefits in excess of \$2 billion and increased customer delight by 25% in less than three years through its Six Sigma initiatives (Jones, 2004). Importantly, Bank of America's experience demonstrates the applicability of Six Sigma beyond traditional manufacturing processes. Indeed, Honeywell found that the average savings it achieved from service

* Corresponding author. Tel.: +1 336 758 3687.

E-mail addresses: shafersm@wfu.edu (S.M. Shafer), sbmoeller@katz.pitt.edu (S.B. Moeller).

¹ Tel.: +1 412 648 0137.

projects were double that of manufacturing projects (Bossidy and Bonsignore, 1999). Motorola, the inventor of the Six Sigma methodology, estimated that over the 20 plus years it has deployed Six Sigma it has documented savings in excess of \$20 billion (Motorola, 2011). Six Sigma has also been credited as an important contributor to its winning the Malcom Baldrige Award for Quality in 1988 (Hahn et al., 1999).

Although there is fairly large and growing body of anecdotal evidence associated with the benefits of implementing Six Sigma, there is very little systematic and rigorous research investigating these benefits. Linderman et al. (2003) argue that although Six Sigma has had a substantial impact on industry, the academic community lacks theory as a basis for research on Six Sigma. Antony (2004) agrees and notes that despite the huge impact Six Sigma has had on industry, the academic community lags behind in its understanding of it. Schroeder et al. (2008) further argue that research is needed to determine the impact Six Sigma has on performance improvement.

The purpose of this study is to investigate the impact adopting Six Sigma has on corporate performance. To accomplish this objective we study the performance of organizations that have publically announced or have received other publicity about their adoption of Six Sigma. Beyond providing a clear adoption date, such public disclosures may also serve as a proxy regarding the organization's commitment to Six Sigma in a similar fashion to the way Hendricks and Singhal (1997) used quality award winners as a proxy for effective TQM implementation.

The results of the study indicate the adoption of Six Sigma positively impacts organizational performance primarily through the efficiency with which employees, but not assets, are deployed. There is no evidence that Six Sigma negatively impacts corporate performance. In addition, the results suggest that better performing firms adopt Six Sigma and they continue their performance advantage after adoption. Furthermore, the performance advantage for the Six Sigma firms in terms of employee productivity tended to be larger after adopting Six Sigma and tended to increase as additional experience was gained with Six Sigma. The benefits of adopting Six Sigma were observed in both the static analysis that assessed the performance of the sample Six Sigma firms at discrete points in time and the dynamic analysis of the Six Sigma firms' rate of improvement on many different benchmarks.

This research extends previous research in several important ways. First, we evaluate a variety of different benchmarks to ensure that the benchmark choice is not driving the results. At one end of the spectrum of benchmarks, we take a naïve viewpoint and use an industry adjusted performance of our sample Six Sigma firms. At the other end of the spectrum, we follow Barber and Lyon (1996) and compare a sample Six Sigma firm's performance to the performance of the closest matched firm and a portfolio of control firms matched to it on the basis of industry, year, and similar past performance. On all of the benchmarks, we do many robustness tests including when and how we match the sample firm to the benchmark and across all of these variations, our results are consistent.

Second, we investigate the impact of Six Sigma on operating performance over a ten year period. Investigating the long-term effects of adopting Six Sigma addresses important gaps in the literature. To carry out this investigation, the event study methodology is employed. The ten year period consists of three years prior to Six Sigma implementation, the event year corresponding to the year Six Sigma was adopted, and six years post Six Sigma implementation. Pre-implementation performance data is used for performance matching Six Sigma sample firms with control firms as well as to investigate the role past firm performance plays in motivating firms to adopt Six Sigma. A six-year post-implementation period is used given an expected lag between Six Sigma implementation and the realization of performance benefits. Previous

research has indicated a two and a half year or longer lag between implementing total quality management (TQM) and improved performance (GAO, 1991; Powell, 1995). Likewise, Hendricks and Singhal (2001a, b) suggest a three to five year period to implement an effective TQM program. The ten year period was also chosen so that short-term and longer-term patterns in the performance of the sample Six Sigma firms could be investigated. For example, one of the most interesting results observed was that the Six Sigma firms outperformed their matched portfolios in year -3 in terms of Operating Income/Total Assets (OI/A), Operating Income/Number of Employees (OI/E), and Sales/Number of Employees (S/E), then experienced a significant decline in performance prior to adopting Six Sigma on these three measures, and finally exhibited a quick rebound in year $+1$ upon adopting Six Sigma. Likewise, as an example of longer term patterns, the performance advantage for the Six Sigma firms in terms of employee productivity tended to be larger after adopting Six Sigma and tended to increase as additional experience was gained with Six Sigma.

Third, beyond extending the research investigating the impact of Six Sigma on firm performance, an additional contribution of this research is to provide performance benchmarks for organizations that have adopted or are considering adopting Six Sigma. Also, the inclusion of commonly used measures of corporate performance including OI/A, Operating Income/Sales (OI/S), OI/E, Sales/Assets (S/A), and S/E facilitate comparisons with previous research.

This paper is organized as follows. Section 2 reviews the existing empirical research related to process improvement methodologies and firm performance. Section 3 provides the theoretical development for Six Sigma's impact on corporate performance, our research hypotheses, and the performance variables included in the study. Following this, our research methodology is discussed in Section 4. Our empirical results are presented and discussed in Section 5. Finally, the paper is concluded in Section 6 with a discussion of limitations and avenues for future research.

2. Review of empirical evidence of quality and process improvement initiatives on corporate performance

While Six Sigma is the latest process improvement methodology, the influence of earlier process improvement methodologies in its development, particularly TQM and JIT/lean, are readily apparent. In this section we critically review the empirical research investigating process improvement methodologies on corporate performance in order to understand what has been studied and then based on this understanding highlight the gaps in the literature addressed by the present study.

While there is a substantial body of empirical research investigating quality and process improvement initiatives on corporate performance, rigorous research investigating the impact of Six Sigma on corporate performance has been limited (Foster, 2007). This is supported by observing that only two of the 23 research contributions encountered in the literature review for this study investigated the impact of Six Sigma on corporate performance. Approximately half the studies investigating the impact of various process improvement approaches on corporate performance utilized event studies and the other half utilized surveys.

Fortunately, rigorous empirical research investigating the impact of Six Sigma is beginning to emerge including the use of event studies (Goh et al., 2003; Foster, 2007) and surveys (Lee and Choi, 2006). While limited in quantity, this research tends to contradict much of the anecdotal evidence because an overwhelmingly positive relationship between Six Sigma and corporate performance has not been found. For example, Foster (2007) found the impact of Six Sigma on operating and financial performance

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