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1-1-2010

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Yasin Ozcelik
Fairfield University, yozcelik@fairfield.edu

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Peer Reviewed

Repository Citation
Ozcelik, Yasin, "Do business process reengineering projects payoff? Evidence from the United States" (2010). *Business Faculty Publications*. 17.
http://digitalcommons.fairfield.edu/business-facultypubs/17

Published Citation
Ozcelik, Yasin. 2010. Do business process reengineering projects payoff? Evidence from the United States. International Journal of Project Management 28 (1), 7-13.

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Do Business Process Reengineering Projects Payoff? Evidence from the United States

Revised - February 2009

Abstract

This paper examines whether implementation of Business Process Reengineering (BPR) projects improve firm performance by analyzing a comprehensive data set on large firms in the United States. The performance measures utilized in the paper are labor productivity, return on assets, and return on equity. We show that firm performance increases after the BPR projects are finalized, while it remains unaffected during execution. We also find that functionally focused BPR projects on average contribute more to performance than those with a broader cross-functional scope. This may be an indication that potential failure risk of BPR projects may increase beyond a certain level of scope.

Keywords: *Business process reengineering; value and benefit; statistical analysis*

1. Introduction

Business Process Reengineering (BPR) is defined as a radical redesign of processes in order to gain significant improvements in cost, quality, and service. Firms have been reengineering various business functions for years, ranging from customer relationship management to order fulfilment, and from assembly lines to logistics. Anecdotal evidence suggests that many organizations gained benefits from BPR projects [1]. For instance, the CIGNA Corporation successfully completed a number of BPR projects and realized savings of $100 million by improving its customer service and reducing operating expenses [2]. Similarly, reengineering the accounts payable process at the Ford Motor Company increased the speed of payments and improved company relations with suppliers [3]. Arguably, some BPR projects fail to meet expectations. A survey conducted by the Arthur D. Little consulting firm found that 85% of executives surveyed were not satisfied with the outcome of their BPR projects [4]. Moreover, a series of studies in the early 1990s found that nearly 70% of BPR initiatives had actually failed [5] or delivered less than they had promised [6]. Such poor outcomes may be attributed to several factors, including (i) expecting too much too soon [3], (ii) undertaking projects without a comprehensive cost-benefit analysis, (iii) lack of expertise on redesigning a set of related activities [7], and (iv) lack of partnership between internal Information Technology (IT) department and other parts of firms [8].

BPR projects, by their nature, entail major changes in business processes that may lead to organizational instability and failure. Therefore, it is reasonable to expect BPR projects to have a significant and measurable effect on firm performance. In this paper, we empirically investigate the performance effects of BPR projects both during and after the implementation periods using a new annual data set covering the period between 1984 and

2004. We utilize labor productivity, return on assets, and return on equity as firm-level performance variables. We use a panel-data regression model in order to take into account the cross-sectional and time-series nature of the data. We show that performance variables of firms remain unaffected during the implementation period of the BPR projects, which generally creates an initial turmoil in firm operations. The firm performance, however, significantly increases after the BPR projects are successfully completed. We also find that functionally focused BPR projects contribute more to performance than those with a broader cross-functional scope, suggesting that failure risk of BPR projects may increase beyond a certain scope.

The paper is organized as follows. In the next section, we briefly survey previous studies on the topic, and then present our hypotheses in Section 3. We describe our data in Section 4 and regression variables in Section 5. We then describe our empirical methods in Section 6. Finally, we provide the regression results in Section 7 and conclude in Section 8.

2. Literature Review

BPR was first described by Davenport and Short [9] and Hammer [10]. Despite the growing popularity of BPR in 1990s, different management consultants used the term as a way to promote their proprietary methods, which led to confusion and disagreements [11]. Responding to the claims made for BPR and the resulting confusion, the academic community criticized BPR for having no sound theoretical basis [12]. Deakins and Makgill [13] argues that the original literature on BPR was essentially anecdotal, lacking rigorous research to support its assertions. More recent literature suggests that the first generation of BPR, which suggests radical changes in business processes, is evolving in to a modest process management, which is softened by the lessons learned from successes and failures in the course of implementations. The contemporary definition of BPR, therefore, encompasses a continuum of approaches to process transformation that may include both radical and incremental improvements, depending on the nature of the problem. In fact, many studies have been published in the literature in order to explain and promote this new approach to BPR, including Davenport et al. [14], Hammer [15], Hammer [16], Becker et al. [17], El Sawy [18], Grover and Kettinger [6], Kalakota and Robinson [19], Silver [20], and Smith and Fingar [21]. Nevertheless, even the recent literature is rife with anecdotal evidence and short on empirical evidence of performance impacts of BPR projects. This indicates that there is still a need to better measure BPR implementations through objective measures, and to relate them to organizational performance in the context of other variables that may also affect performance, which is the main focus of this paper.

The number of studies on the impact of BPR projects on firm performance is small but growing. Most studies collectively suggest that there are substantial benefits for firms that successfully implement the structural changes associated with BPR projects [22, 23]. Hunter et al. [24] and Murnane et al. [25] confirm this claim by analyzing data from the banking industry per se. Devaraj and Kohli [26] show that investments in IT can contribute to a higher level of revenue if they are supported by BPR initiatives. By studying the effect of three related innovations (IT, workplace reorganization, and new products and services) on demand for skilled labor, Bresnahan et al. [27] find that the demand for skilled labor is complementary with all the three innovations. Finally, Bertschek and Kaiser [28] find that workplace reorganization induces an increase in labor productivity that may be attributable to complementarities between IT and workplace reorganization.

3. Hypotheses

BPR projects involve large investments in physical as well as human capital. The monetary costs of a BPR project include purchasing new equipment, hiring new personnel, and training employees to handle new roles. Indeed, organizations implementing BPR projects may need to increase their training budgets by 30 to 50 percent [29]. BPR projects may also have non-pecuniary costs due to problems encountered during implementation [30]. Such problems include (i) communications barriers between functional areas [31], (ii) lack of communication between top-level managers [32] as well as between BPR teams and other employees [33], (iii) resistance from employees [34], (iv) management reluctance to commit resources to BPR projects while expecting quick results [35], and (v) failing to address employee habits during implementation [36]. All of these factors suggest the following hypothesis:

Hypothesis 1. *Firms experience a drop in performance during BPR project implementation.*

Once BPR projects are finalized and implementation risks are resolved, employees are likely to become more comfortable with the new process design, and hence firms may be able to operate more efficiently. Thus, we expect firm performance to surpass its previous levels after the implementation, which leads to our second hypothesis:

Hypothesis 2. *Firm performance improves after the completion of BPR projects.*

A third issue of interest is the effect of project scope on firm performance. The scope of BPR projects vary; some projects focus on a single business function, such as order fulfilment or accounts payable, while others may be directed towards multiple functions. The scope of BPR projects may potentially affect the level of impact on firm performance. However, studies in the literature are far from providing consistent evidence on the direction of the impact. For example, Berry et al. [37] find that BPR projects with a large scope make the highest possible impact on firm performance. On the other hand, Dean [38] finds that the application of BPR across the entire firm may not produce as much benefit as a functionally-oriented project, such as switching to Just-in-Time (JIT) production system. In order to better investigate this issue empirically, we incorporate a scope variable into our analysis and suggest the following hypothesis:

Hypothesis 3. *The effect of BPR projects on firm performance increases with project scope.*

4. Description of Data

Our data covers BPR projects conducted by large U.S firms between 1985 and 2000. In order to avoid selection bias, we included in our sample all of the firms appearing in the 1998 edition of the Fortune 1000 list, regardless of whether they have implemented a BPR project. We used the ABI/INFORM and Lexis/Nexis online news resources to obtain press announcements for BPR projects, as well as the COMPUSTAT to extract our data. All of the monetary values in our data were inflation-adjusted by using the Consumer Price Index (CPI) values of the Federal Reserve Bank of Minneapolis, with the base year being chained at 1982-1984. We eliminated some of the firms due to missing data, reducing our sample size to 832 firms with a time span between 1984 and 2004. Of these firms, 93 have implemented a BPR project. We classified the BPR projects in to two groups with respect to project scope. Projects that likely affect a single business unit were classified as being functionally focused. Examples include reengineering of records management, sales force, and labor scheduling. Projects that potentially affect several departments were considered to have a cross-functional focus. Examples of such projects include restructuring and strategic rethinking of business for cost cutting or revenue growth purposes. Overall, 56 of the 93 projects in our data set were cross-functional and 37 were functionally oriented.

5. Description of Variables

5.1. Dependent and Independent Variables

We utilize labor productivity, Return on Assets (ROA), and Return on Equity (ROE) as dependent variables to measure firm performance from several dimensions. Table 1 below outlines the construction of these measures.

[Insert Table 1 here]

Our key independent variables are the following. The implementation period is distinguished with a dummy that takes a value of one for all years during which a firm implements a BPR project, and zero otherwise. The post-BPR period is designated with another dummy that takes a value of one during all years after the implementation, and zero otherwise. These dummies allow us to take a longitudinal approach and are used for testing Hypotheses 1 and 2. Regarding Hypothesis 3, each of the above dummies is separated into two dummies, one for cross-functional BPR projects and the other for projects with a functional focus. For example, the dummy for the implementation period of cross-functional BPR projects is one for all years during which a firm implements the associated BPR project, and zero otherwise.

5.2. Control Variables

Our model includes four firm-level and two industry-level control variables. Past empirical studies have identified these controls as key determinants of firm performance [39, 40].

5.2.1. Firm-level Controls: Our firm-level control variables are firm size, total IT budget, advertising expenditure, and market share. First, we use the natural logarithm of the number of employees as a proxy for firm size, as is standard in the literature. Second, in order to distinguish the effect of BPR projects on performance across firms with varying degrees of technical capability, we utilize the total IT budget as another firm-level control variable.

Third, there is ample evidence in the literature supporting a positive relationship between advertising expenditure and firm performance [41, 42, 43]. Finally, market share is included as a control variable because both the efficiency theory [44, 45] and the market power theory [46, 47] provide evidence for a relationship between market share and firm performance. Market share can also serve as a proxy for other firm-specific assets not specifically captured in our study, such as managerial skills [48, 49].

5.2.2. Industry-level Controls: The structure of an industry impacts the performance of firms within the industry [50]. We, therefore, utilize two variables frequently used in the literature to account for variation in firm performance due to idiosyncratic characteristics of different industries at the 2-digit SIC level: industry concentration and industry capital intensity. Consistent with the literature, industry concentration in our study is proxied by the four-firm concentration ratio, which is the total market share of the four largest firms in an industry. Industry capital intensity is included in the analysis to capture potential effects of entry barriers on firm performance. It is calculated as the sum of all capital expenditures divided by the sum of all sales in an industry.

5.2.3. Time Controls: We use separate dummy variables for each year to capture economy-wide shocks that may affect firm performance. The use of such dummies also helps us remove possible correlation between macroeconomic trends and firms' performances during the sample period.

6. Empirical Methods

We perform a panel data analysis to test our hypotheses as it accounts for both the time series and cross-sectional nature of our data. Panel data models have two estimation methods: fixed effects and random effects. The advantage of fixed effects estimation over random effects is that the former method allows the unobserved effect to correlate with the observed explanatory variables. The disadvantage is that fixed effects estimation produces less efficient estimators than random effects estimation can provide. The generally accepted way of choosing between fixed and random effects is running a Hausman test, and our regression results unanimously suggest using fixed effects estimation for all the regressions.

We use the logarithm of the numerator of each performance measure as a dependent variable, and the logarithm of its denominator as a control variable. This formulation relies on a property of the logarithm function, log(x/y) = log(x) – log(y). Such a specification has been used in past research as it provides flexibility in the relationship between the numerator and the denominator, while still retaining the interpretation as a performance measure [51]. Thus, the general form of the regression models used for testing Hypotheses 1 and 2 is:

$$\begin{aligned} \textit{log (performance measure numerator)}_{it} = {} & \textit{intercept}_i + \textit{log (performance measure denominator)}_{it} \\ & + \textit{implementation}_{it} + \textit{post-implementation}_{it} \\ & + \textit{firm controls}_{it} + \textit{industry controls}_{it} \\ & + \textit{year dummies}_t + \varepsilon_{it} \end{aligned} \tag{1}$$

The implementation variable above is derived by interacting the dummy for the implementation period with firm size. This is equivalent to specifying that both the costs and benefits of BPR projects during the implementation period are proportional to firm size. We believe this is a more realistic specification than simply assuming identical costs and benefits across all firms, which would be the case if we were to include in the analysis the implementation period dummy per se. By the same token, the post-implementation variable is derived by interacting the dummy for the post-implementation period with firm size.

As for testing Hypothesis 3, we segment the implementation and post-implementation variables in to two types: functionally focused and cross-functional. Again, these variables are derived by interacting the associated dummies with firm size. Hence, the formulation of the fixed effects panel data models when investigating the effect of project scope becomes:

$$\begin{aligned} &\textit{log (performance measure numerator)}_{it} = \textit{intercept}_i + \textit{log (performance measure denominator)}_{it} \\ &\quad + \textit{functional implementation}_{it} + \textit{functional post-implementation}_{it} \qquad (2) \\ &\quad + \textit{cross-functional implementation}_{it} + \textit{cross-functional post-implementation}_{it} \\ &\quad + \textit{firm controls}_{it} + \textit{industry controls}_{it} + \textit{year dummies}_t + \varepsilon_{it} \end{aligned}$$

7. Regression Results

The correlation matrix for all of our independent variables is presented in Table 2 below. All of the correlation entries among different variables in this table are significantly below 0.9, demonstrating that multicollinearity does not pose a serious problem to our analysis.

[Insert Table 2 here]

The panel data regression results for the formulation described in Equation (1) above are presented in Table 3, where each column represents a different performance measure regression. According to Table 3, we do not find evidence supporting Hypothesis 1. None of the coefficients of the implementation variable is significantly different from zero. This may imply that potential negative impacts of BPR projects on firm performance variables during the implementation period are completely offset by their positive effects in the same period. Hypothesis 2 is uniformly supported as the coefficients of the post-implementation variable in Table 3 are significantly positive for all regressions. In other words, the firms in our sample have improved their performance in all three areas of interest after successfully implementing their BPR projects. Specifically, they have generated more sales and income per unit of input. In summary, we find a statistical association between improved firm performance and BPR projects during the post-implementation period without a significant drop in performance during the implementation period.

[Insert Table 3 here]

Recall that Hypothesis 3 is about the effect of project scope on firm performance. One would expect BPR-related benefits to increase with project scope, assuming that the risks of project implementation do not weigh in beyond a certain level of scope. The panel data regression results for the formulation described in Equation (2) are presented in Table 4.

[Insert Table 4 here]

Similar to the results regarding Hypothesis 1, we do not find a significant association between functionally focused or cross-functional BPR projects and firm performance during the implementation period, with the exception that functionally focused BPR implementation is (weakly) associated with higher return on equity during the same period (p value < 0.05). On the other hand, we do observe a statistically significant (and positive) relationship between functionally focused BPR implementation and all measures of firm performance after the implementation period. Compared to firms that have not engaged in BPR, firms that implemented a narrowly focused project have generated more sales and income per unit of input after the implementation. Interestingly, we do not find a statistically significant association between cross-functional BPR projects and firm performance after the implementation period. In fact, the coefficient for the cross-functional post-implementation variable is smaller than that for the functional post-implementation variable for all estimations. This may imply that firms implementing BPR projects with a larger focus make a higher level of investment in organizational capital and assets, which may not lead to comparable increases in sales and income after the implementation period. Another implication of this finding is that the failure risk of BPR projects may increase beyond a certain level of scope, if not managed properly [52]. In a sense, this result is parallel to the observations reported in a relevant case study [38]. In fact, the existence of a high level of risk in large BPR projects may also explain the reason that many firms choose to implement only portions of enterprise-wide systems, such as Enterprise Resource Planning (ERP) [53, 54] that usually provides a means to do BPR [55].

The coefficients of our control variables in Tables 3 and 4 are in the expected direction. Firm size, IT budget, advertising expenditure, and market share are positively associated with all of our performance variables. Industry concentration is negatively associated with all of our performance variables. This implies that the average performance of a firm improves with the level of competitiveness in its industry, a finding that parallels those of Melville et al. [56]. Finally, we find a positive relationship between industry capital intensity and firm performance, which supports the view that incumbent firms in capital intensive industries could earn higher profits since they are likely to face fewer competitors [39].

8. Conclusion

This paper contributes to the growing literature on the business value of BPR projects. We empirically investigated the effects of BPR projects on firm performance both during and after the implementation periods by considering a variety of measures, including labor productivity, return on assets, and return on equity. We utilized panel data regression models, and explicitly considered the scope of BPR projects in our empirical analysis. We used a comprehensive data set spanning the period between 1984 and 2004. We found that while overall performance of firms remains unaffected during the implementation of the BPR projects, it increases significantly after the implementation period. We also found that functionally focused BPR projects on average are associated more positively with firm performance than those with a cross-functional scope. This may indicate that potential failure risk of BPR projects may increase beyond a certain level of scope.

There are certain limitations to this study. First, our results capture the effect of BPR initiatives averaged over a wide variety of firms and their projects. Although we report a significant association between improved firm performance and BPR implementation at the functional level, it is conceivable that some of these projects could have actually failed. Hence, our results can only represent an average performance measurement across multiple firms and projects. Second, our observations are unavoidably limited to those BPR projects that are publicly announced. Therefore, we may have missed some of the projects that have not been announced, and consequently miscoded some companies as non-implementers when, in fact, they have undertaken a BPR project. Finally, our empirical results need to be interpreted as correlations rather than estimates of a causal model.

There are interesting avenues for future research on this subject. Arguably, effectiveness of BPR projects may not be uniform across all activities of a firm. Therefore, our model can be extended to analyze the effects of BPR at the strategic business units of firms, rather than at the organizational level. This would be possible by defining new performance measures for different business units and comparing the resulting differences across them. Such an analysis may provide more specific insights about the design and value of BPR initiatives to project managers.

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Table 1. Construction of performance measures

Performance Measure	Numerator	Denominator
Labor Productivity	Sales	Number of Employees
Return on Assets (ROA)	Income	Assets
Return on Equity (ROE)	Income	Equity

Table 2. Correlation matrix for independent variables

	Employees	Assets	Equity	IT budget	Advertising	Market share	Industry concentration	Industry cap. intensity
Employees	1.000							
Assets	0.6040 ***	1.000						
Equity	0.6665 ***	0.8950 ***	1.000					
IT budget	0.7093 ***	0.8617 ***	0.8149 ***	1.000				
Advertising	0.7774 ***	0.8463 ***	0.8472 ***	0.8179 ***	1.000			
Market share	0.2426 ***	0.2331 ***	0.2232 ***	0.2258 ***	0.2163 ***	1.000		
Industry concentration	-0.0649 ***	-0.2361 ***	-0.2288 ***	-0.1860 ***	-0.2244 ***	0.4561 ***	1.000	
Industry cap. intensity	-0.0264 **	-0.0198 *	0.0676 ***	0.0010	-0.0215 **	-0.0062	-0.0166 *	1.000
*Note: *** p<0.001; ** p<0.01; * p<0.05.*								

Table 3. Regression results for during and post-BPR implementation

Dependent Variable	log (sales)	log (income)	log (income)
Interpretation	Labor productivity	Return on assets (ROA)	Return on equity (ROE)
During implementation	-0.00028	-0.00105	0.00288
Post-implementation	0.00433 **	0.01038 **	0.01335 ***
log (employees)	0.43507 ***	0.15258 ***	0.11808 ***
log (assets)		0.57193 ***	
log (equity)			0.59733 ***
log (IT budget)	0.17298 ***	0.04928 ***	0.05271 ***
log (advertising)	0.07544 ***	0.04186 ***	0.02936 ***
Market share	1.90082 ***	0.09088	0.21720
Industry concentration	-0.07500 **	-0.22265 **	-0.20055 **
Industry capital intensity	0.27603 **	0.77605 **	0.44557 *
R^2	0.8091	0.7044	0.7545
*Note: *** p<0.001; ** p<0.01; * p<0.05.*			

Table 4. Regression results for the effect of project scope

Dependent Variable	log (sales)	log (income)	log (income)
Interpretation	Labor productivity	Return on assets (ROA)	Return on equity (ROE)
Functional during implementation	0.00225	0.01600	0.01833 *
Functional post-implementation	0.00596 **	0.02049 ***	0.02209 ***
Cross-functional during implementation	-0.00173	-0.01058	-0.00588
Cross-functional post-implementation	0.00325	0.00399	0.00783
log (employees)	0.43500 ***	0.15223 ***	0.11758 ***
log (assets)		0.57113 ***	
log (equity)			0.59664 ***
log (IT budget)	0.17287 ***	0.04881 ***	0.05236 ***
log (advertising)	0.07545 ***	0.04208 ***	0.02957 ***
Market share	1.89565 ***	0.05797	0.18845
Industry concentration	-0.07531 **	-0.22466 **	-0.20338 **
Industry capital intensity	0.27894 **	0.79223 **	0.45955
R^2	0.8091	0.7047	0.7548

*Note: *** p<0.001; ** p<0.01; * p<0.05.*