

ERP: Drilling for Profit in the Oil and Gas Industry

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Introduction

Most large companies have adopted some form of enterprise resource planning (ERP) system. A survey of IT executives in the United States showed that ERP was the second most important spending category after IT infrastructure [9]. In many cases, the implementation of an ERP system was a long and expensive ordeal that involved extensive restructuring of businesses and reengineering of processes.

While the potential benefits of ERP have been extolled frequently and much has been written about individual company experiences, only limited evidence has been produced that implementation of ERP does, on average, lead to enhanced performance. To the best of our knowledge, this is the first industry analysis on ERP because previous work has been limited to case studies and industry cross-sectional analyses.

Several research studies have validated that IT provides productivity and profitability advantages. However, questions remain because it is not clear whether advantages from IT contribute, and to what degree they might contribute, to operational efficiency and profitability. For example, if the same IT is implemented by all firms in an industry, will industry profits from IT disappear? Due to the fact that for many years large companies developed their information systems independently, there have been limited opportunities to evaluate the implementation of similar IT infrastructure across companies. This study seeks to extend prior work by performing a longitudinal study of implementation of ERP systems in a specific industry.

According to Porter [7], each industry is affected by new information technology in different ways and drawing general conclusions about how new IT affects firms across industries would be a mistake. The oil and gas industry was selected because ERP plays a major role in standardizing business processes in this industry [8]. In this role, ERP helps firms knit together disparate operations and turn its global scale and large size to its advantage. Also, a commodity-product industry, like the oil and gas industry, helps us control for other influences that may have affected the performance of oil and gas companies during the study period. The ERP adopting firms are those that adopted SAP.

This research applies a new methodological approach toward understanding ERP implementation because rather than looking at ordinary measures of firm performance, we look at strategic performance measures (SPM) that can only be utilized if one delves into data that is not found on the financial statements. This is the first study that shows the sources of profitability after an ERP implementation, and will help managers understand the strategic and managerial implications of ERP implementations. Our analysis compares performance changes of ERP adopting firms versus non-adopting firms over a fifteen-year period (1990-2005), which is the period when this industry was being transformed by increased use of technology in the oil and gas industry. Therefore, we see how the implementation of ERP affected firm performance during this period in relation to non-adopting firms.

ERP and the Oil and Gas Industry

When processes are standardized, data is consistent, as opposed to having many different systems across the company. In an industry with so many units dispersed

geographically, an enormous number of wells, complex supply chain demands and increased competition, standardization plays an important role, and ERP provides it. According to Patricia Hewlett [6], vice president of global information technology at Exxon Mobil, the ultimate payoff from standardization is not just cost savings from achieving economies of scale, it is also the competitive advantage and flexibility added to the business by allowing rapid movement into new markets and workload adjustments among offices.



Figure 1

With regard to assets, a lack of current and accurate information may cause some companies to delay the replacement of under-performing assets, or upgrade entirely functional assets too soon. In contrast, an ERP system will provide managers with pertinent timely information about external events and internal resources, thus improving the quality of managers' decisions.

Research Design

There are two components of our research design that make it unique. First, we break down profitability into its strategic performance measures [1, 5]. These strategic performance measures are productivity, price recovery, product mix and capacity utilization ratio [2, 3].

Table 1 – Definitions of each variable

Variable	Definition [2]
Profitability Ratio	It is defined as the ratio of a firm's sales revenue to its expenses during a time period.
Productivity Ratio	It measures the efficiency of business processes by comparing the actual usage of inputs to a benchmark measure of inputs based on best practices or industry averages.
Capacity Utilization Ratio	It measures the efficiency of a firm in utilizing capacities of fixed resources.
Product Mix Ratio	It reflects improvements in the allocative efficiency of the firm in focusing its resources on the more profitable products.
Price Recovery Ratio	It measures how effective the company is in maximizing output prices while minimizing input prices.

Second, the way in which we measure the performance changes in the adopting firms versus the non-adopting firms before and after the implementation. Because we catch the period when the industry was being transformed by major investments in ERP – we see successive implementations as firms adopted SAP and how their performance changed relative to firms that did not adopt SAP during this period.

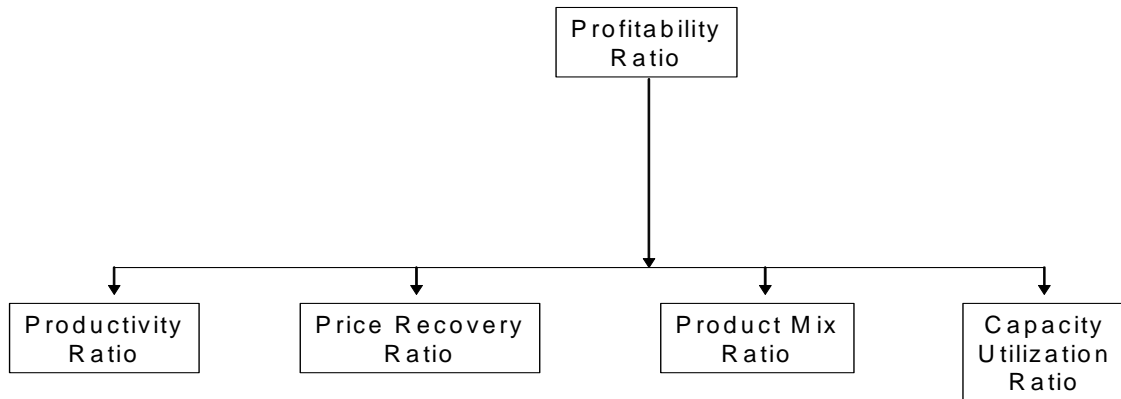


Figure 2

Banker et al. [4] performed a longitudinal examination of the multi-period impact of an incentive plan at several stores operated by a major firm in the department store industry. They used monthly store sales reports for a 66-month period for the 15 stores that implemented the incentive plan and the 19 other stores in the same geographic region that did not. Their results indicate that sales increased when the plan was implemented and that the increase persisted over time. We use a similar model to test whether the average firm with SAP outperformed the average firm without SAP both before and after the implementation. This analysis allows us to isolate the contribution of SAP while controlling for other factors that are likely to influence the strategic performance metrics. The average performance of the non-adopting firms was used as a benchmark for the performance of the SAP firms in the corresponding quarter. This controls for changes in strategic performance metrics over time due to potentially unique strategies of firms as well as seasonal and regional economy-wide effects. To ensure that time effects are removed from the data, we converted dollar data to constant 1990 dollars. We then tested for time series trends and transformed the data to remove time trends. To control for

calendar year related time effects and other possible seasonal influences, a discrete indicator was generated. For further details, see [8].

Data

In the oil and gas industry, many companies installed SAP R/3 and other modules from SAP between 1990 and 2005. The deep penetration of SAP in this industry provides an opportunity to investigate how adoption of similar information technology (IT) infrastructure by a large number of firms in a single industry influenced the performance of those firms relative to non-adopting firms. Moreover, because SAP is dominant in this industry, it provides more homogeneity in terms of the type of IT used across firms.

Our data, obtained directly from SAP, includes information about the start and completion dates for SAP installations. The data provided by SAP included proprietary data on all license agreements for the SAP R/3, mySAP Business Suite, and SAP for Oil & Gas systems sold by SAP over the time period 1990 to 2005. Financial variables were obtained from Standard and Poors' Compustat database. For the companies that did not install SAP, we performed a detailed search of press releases and other corporate information to determine whether non-adopting companies implemented other ERP systems or did not implement any ERP system at all.

In order to verify that non-adopting firms did not adopt another ERP package, we repeated this detailed search for the sample provided by SAP without using the data provided by SAP. Using this search procedure, 28 out of 29 firms from the SAP sample were identified as SAP users, only one firm could not be identified as a SAP user so the

effectiveness of this criterion on SAP users was 97%. Therefore, the criterion described above is a reliable way to identify if a firm in the Oil and Gas industry installed or did not install SAP. A possible limitation of this analysis is that there is a 3% chance that a non-adopting firm may have installed another ERP package.

Our final sample consists of 98 firms. Of these firms, 29 performed a full installation of SAP, 30 did not install any ERP system, seven installed other ERP packages, and 32 performed a partial SAP installation. Firms that performed a partial SAP installation were not included in the dataset because they could not be classified as ERP adopting nor non-adopting. Firms that were subsidiary companies of another company in the data and firms with less than two years of data were also removed. In addition, non-SAP firms with quarterly average sales less than \$200 million were removed to avoid a small-firm bias in the non-adopting firms. Our primary analysis is based on a comparison between our SAP sample of 29 firms and non-ERP sample of 30 firms. For robustness, we also performed a separate analysis that included the 7 firms that implemented other ERP in the non-adopting sample. See Table 2.

Industry	Number of Firms		
	SAP	non-SAP	
		non-ERP	other ERP
Oil and Gas	29	30	7

Table 2

Impact of SAP adoption on strategic dimensions of profitability

Table 3 presents results of our regression estimation of the model for the following strategic performance measures: profitability ratio, productivity ratio, capacity utilization ratio, product mix ratio, and price recovery ratio. The results are robust when

the non-adopting firms include both the 30 non-ERP-adopting firms and the 7 firms that adopted an ERP package other than SAP, therefore validating our results from Table 3. For further details, see [8].

Our results after implementation show that oil and gas firms that adopted SAP did realize performance improvements in relation to non-adopting firms. Profitability ratio improved 9.6% after the implementation. The explanation for this improvement is that information originates and flows through every process of the oil and gas industry, from initial field exploration to drilling, production and delivery, to more general requirements in the business office. In order to compete in this environment, SAP helps companies to speed and process the flow of data, from the oil field across the entire upstream business. In the oil and gas industry, improvements in efficiency are manifest through greater throughput and better utilization of resources that support operations and sales. From Table 3, we see that productivity ratio improves 4.3% after the implementation. Therefore, an SAP installation leads to leaner operations, and develops more continuous workflow by integrating the whole value chain from raw material to finished product.

Capacity utilization improves 7.8% after the SAP implementation. Thus, companies that implement SAP identify demand shifts and swiftly adjust their production schedules, achieving greater capacity utilization. Better capacity utilization leads to lower average costs.

Table 3 – Results for Components of Profitability Ratio

SAP versus non-ERP	<i>After implementation</i>	<i>Adjusted R²</i>
Profitability Ratio	0.096*	0.923
Productivity Ratio	0.043*	0.929
Capacity Utilization Ratio	0.078*	0.929
Product Mix Ratio	0.003	0.994
Price Recovery Ratio	0.051	0.783
Interpretation	* Results are significant, and show the percentage improvement in the corresponding metric after the implementation of SAP.	The model has a good fit

We did not find significant values for improvements in price recovery and product mix. Although price recovery provides information about a company’s success in meeting customer needs while effectively managing its supply chain, in a commodity-product industry such as oil and gas, there are no improvements in price recovery. Concerning product mix, while this ratio can be higher for companies that adjust their product mix swiftly in response to demand shifts, we do not see improvements because the oil and gas industry uses non-interchangeable dedicated assets. We drilled down as deep as oil versus gas, and this was not sufficient to detect the impact of SAP on product mix.

Conclusion

This study contributes to IT literature in three important ways. First, we utilize an alternative methodological approach that requires information beyond that which is provided by financial statements. This alternative framework uses a sophisticated model

not used before in IT literature. Second, this is the first empirical work to utilize such a model to measure the strategic performance of firms in the oil and gas industry. The source of competitive advantage comes from productivity and capacity utilization. Thus, efficiency gains from enterprise systems are not easily duplicated. The implementation of the enterprise systems bestows process efficiencies and pushes the production frontiers further out, allowing the leading firms to sustain a competitive advantage. Third, previous work has been limited to individual case studies or cross sectional analyses. Here, we extend previous work on the impact of ERP by providing clear metrics to gauge the impact of ERP by focusing on a specific industry. Focusing on a specific industry has an advantage because each industry is different. For example, to compare the return on sales ratio of a firm in the oil and gas industry with that of a consulting business would be useless because of obvious industry differences.

Information about the association between profitability and ERP enables managers and senior executives to recognize the potential contribution of ERP and its strategic and managerial value. As shown in Figure 3, the multidimensional strategic performance approach tells us that ERP impacts productivity and capacity utilization positively and these are the sources of profitability. The results for capacity utilization provide evidence of significant improvements in capacity utilization for SAP-adopting firms versus non-adopting firms after the implementation. Because ERP systems enhance the ability of the company to collect, process and use information about input supply, output demand and internal production, companies are able to add value for its customers by more closely matching their production to customer needs. This effect can

be appreciated in the productivity ratio, where improvements in productivity are realized because ERP systems enable better coordination between different productive units.

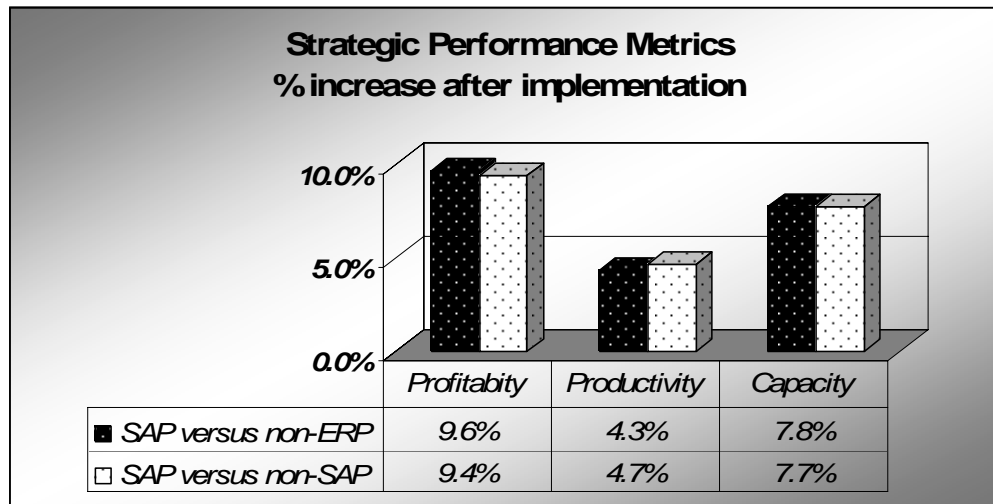


Figure 3

HOW THE ANALYSIS WAS DONE

In order to calculate each of the strategic performance measures, three input costs and two output revenues were used for each firm with 100% of the expenses allocated to the three inputs and 100% of the revenues allocated to the two outputs [2]. The three inputs are cost of products sold, selling general and administrative costs, and capital costs; and the two outputs are crude oil and natural gas. Using publicly available data, we were able to identify oil and gas as separate products. For every company and for every quarter for the period between 1990 and 2005, input and output data were collected from different sources. For further details, see [8]. We deflated input prices and output prices by using the corresponding price indices from the U.S. Bureau of Labor Statistics.

For each strategic performance measure: profitability ratio, productivity ratio, capacity utilization ratio, product mix ratio, and price recovery ratio, a regression model was constructed in which the average performance of the control sample (non-ERP adopting firms) was used as an explanatory variable, and time dummies were used to specify pre-, and post- implementation periods. Time dummies were used because not all the companies completed their SAP implementation at the same time. This model is similar to the one used by Banker et al. [4]. The period before the implementation provides a benchmark for calibrating the performance of SAP-adopting and non-adopting firms after the implementation.

The regression model allows the estimated coefficients to differ across firms, accommodating differences in the impact of ERP on performance across the 29 SAP-adopting firms. We estimated the model over a 62-quarter period from 1990 to the second quarter of 2005 for each strategic performance measure. We took other precautions to ensure the statistical validity of our results; for example, we removed observations with extreme values and performed appropriate statistical tests to rule out potential violations of assumptions underlying the regression model.

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