ERP IMPACT ON NUMBER OF EMPLOYEES AND PERSONNEL COSTS IN SMALL AND MEDIUM SIZED ENTERPRISES
A Panel Data Approach

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Abstract: Enterprise Resource Planning (ERP) vendors have emphasized a positive impact of their ERP projects in company performance and in costs reduction. Recently, some researchers have started to analyze the impact on business performance of the organizational changes that complement IT investments. This study attempts to analyze the impact of ERP implementations in the SMEs' number of employees and personnel costs. We have collected information of 168 Spanish SME during the period 1997-2005, concerning the type of purchased ERP, implementation period, number of employees, personnel costs and some financial indicators. We use two panel data models to compare and analyze the number of employees' evolution and the related personnel costs, before and after ERP implementations. Our preliminary findings suggest that as bigger the SME as lower will be the decrease its number of employees. On the other hand, ERP impacts positively in personnel costs. This trend to increase personnel costs can be explained in the sense that SMEs using an ERP system need people not only with specific operative skills but also with a very holistic approach to understand and obtain maximum benefits to the ERP system.

1   INTRODUCTION

Enterprise Resource Planning (ERP) vendors have emphasized a positive impact of their ERP projects in company performance and in costs reduction. Recently, some researchers have started to analyze the impact on business performance of the organizational changes that complement IT investments. However, most of the research about ERP benefits has been in the form of individual case studies (e.g. McAfee, 1999; Gibson et al., 1999; Tagliavini et al., 2005), while experiences on the field show that for the segment of Small and Medium-sized Enterprises (SMEs), these often fail in recognizing the economic and organizational impacts related to their use of their implemented ERP (Esteves and Bohórquez, 2007).

According to Sircar et al. (2000), both Information Technology (IT) and corporate investments have a strong positive relationship with sales, assets, and equity, but not with net income. In this sense, spending on IT staff and staff training is positively correlated with firm performance, even more than computer capital. Shang and Seddon (2002) have categorized the expected ERP benefits

in their five-dimensional framework: operational, managerial, strategic, IT infrastructure and organizational dimension. This framework provides a detailed list of benefits acquired through ERP implementation. Nevertheless, previous works had considered the impact in number of employees or personnel costs in these organizations.

This research-in-progress study attempts to investigate the impact of ERP implementation in number of employees and personnel costs in SMEs. A common myth around ERP implementations is that they cause a reduction in the number of employees, especially in IT employees previously needed to develop and maintain the prior IT system substituted by the new ERP system (e.g. Mabert et al., 2001; Poston and Grabski, 2001). Additionally, there are some contradictory results on employee turnover. For instance, a study of 233 cases of ERP implementations reported that the impact at organizational level consists mainly in facilitating organizational learning and to foment empowerment between employees (Shang and Seddon, 2002). So far, there has been a lack of research on this topic (Esteves and Bohorquez, 2007).

This paper is structured as follows. First, we describe the theoretical background. Next, we present the research methodology used. Then, we explain the preliminary findings and finally, we draw some conclusions and further work.

2 LITERATURE REVIEW

Although ERP vendors claimed for the impact of their ERP systems in companies' performance, few studies had demonstrated this impact in companies' performance or in enterprise size. The press is plenty of examples of not so successfully ERP implementations and, in some cases, there is the evidence of high expectations before the ERP implementation.

By the late 1990's, the research concerning the IT impact on financial performance broadened with a new research path that focused on the business value of ERP systems. Once adopted within and across organizations, ERP systems achieve the integration of such business functions as accounting, sales and marketing, operations and logistics, and human resources. ERP systems are built on a single database that enables modules to share data, thus speeding up the information flow within organizations.

Empirical studies show little financial gains associated with ERP implementations. For example, Poston and Grabski (2001) examined the impact of ERP systems implementation on firm financial performance during an analysis period of 3 years before and 3 years after ERP implementation. They found no significant improvements in the financial ratios. However, the firms obtained a significant decrease of Cost of Goods Sold (COGS) as a percentage of revenue, in the third year after implementation. In another study, Bharadwaj (2000) results indicate that firms with high IT capability tend to outperform a control sample of firms on a variety of profit and cost-based performance measures. On the other hand, market and managers perceive value in ERP announcements, and ERP implementations, respectively (Mabert et al., 2001; Hayes et al., 2001). Thus, the question about the business value realization of ERP implementations still remains unanswered. One anecdotal answer lies in Hitt and Brynjolfsson's (1996) suggestion that the ERP financial gains are passed on to consumers through lower prices. Or, it may be that ERP financial gains are positively associated with successful ERP implementations. Stratopoulos and Dehning (2000) tested whether successful IT

projects lead to a higher financial performance compared with ineffective IT projects. Their findings reveal that the successful IT investments entail higher financial performance for 3 or 4 years. However, the higher financial performance is short-lived. The quality of ERP implementations is a variable that could have explanatory power when looking into how ERP systems affect the financial performance of adopters. The financial impact of successful ERP adoptions is expected to exceed the financial impact of less successful ERP adopters, because the asset utilization and the business processes efficiency are higher for the former group of companies. Another point of view suggests that when enterprises implement ERP systems, they need to redesign their business processes in a way that information flows smoothly within organizations. Enterprises can not obtain expected returns from ERP investments unless these changes are effectively managed after ERP systems go live (Lee and Lee, 2004).

Summarizing, this ERP literature review provides ambiguity for predicting the impact of ERP on firm size in terms of number of employees and personnel costs. Indeed, there is a lack of studies in this topic for SMEs (Esteves and Bohorquez, 2007).

2.1 Hypotheses Development

The European Union (EU) classifies SMEs in three main categories:

- **Micro enterprises** are defined as enterprises which employ fewer than 10 persons and whose annual turnover or annual balance sheet total does not exceed 2 million euro

- **Small enterprises** are defined as enterprises which employ fewer than 50 persons and whose annual turnover or annual balance sheet total does not exceed 10 million euro

- **Medium enterprises** are defined as enterprises which employ fewer than 250 persons and whose annual turnover or annual balance sheet total does not exceed 50 million euro.

Based on this categorization, our study attempts to analyze the following research issues:

Number of Employees. ERP implementation and usage is likely to affect the SMEs size in terms of number of employees. In particular, SMEs vary in their degree of dependence on skilled people to use the system. As discussed above, SMEs are divided

by EU in categories. Do ERPs will impact in a different way in each of these categories?

H1: According to the SMEs size, ERP implementation and usage are negatively associated with their number of employees.

Personnel Costs. ERP implementation and usage is also likely to affect SMEs personnel costs. In particular, SMEs could obtain important savings in personnel costs. As discussed above, SMEs are divided by EU in categories. Do ERPs will impact in a different way in each of these categories?

H2: According to the SMEs size, ERP implementation and usage are negatively associated with their personnel costs.

3 RESEARCH METHODOLOGY

The literature review shows that ERP impact on enterprises is intrinsically associated with the time dimension. Thus, we have collected data from SMEs in a period range that would include some years previously the ERP implementation and some years after the ERP implementation. For Data analysis, we have used Panel Data approach.

3.1 Panel Data Approach

According to Shu and Strassmann (2005), our data contains both cross-sectional and time series data ranging. Therefore, we have used a panel data model because a simple Ordinary Least Squares (OLS) regression suffers from inefficiency, multicollinearity and correlation between the explanatory variables and the error terms with the estimation being biased. Panel data models have become increasingly popular among applied researchers due to their heightened capacity for capturing the complexity of human behavior, as compared to cross-sectional or time series data models, when used separately. The main motivation for using a panel data approach is to be able to combine the time-series analysis with the cross-sectional approach, taking advantage of a larger number of observations (Hsiao, 2003). Other reasons to use panel data approximation are: controlling for individual heterogeneity; giving more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency (Baltagi, 2005).

3.2 Theoretical Model

As previously explained, most of the research studies have used different methods and models to assess the ERP impact in enterprises with some contradictory results. In our research, we have used a translog production function because it allows better exploration between input variables and it is a more flexible functional form (Evans et al., 2000). We complement this procedure with an appropriate analysis using panel data approach to extent the results and because they will be statistically unbiased and consistent (Shu and Strassmann, 2005).

The explanation of used variables is shown below:

Emp: The number of employees to the SMEs. Logarithmic transformation was performed to eliminate the asymmetries caused by the differences in size among the observational units, which could bias the results by giving too much weight to the observations of the big SMEs.

EmpCosts: Natural logarithm of personnel cost.

Inc: Incomes in thousands of euros. Logarithmic transformation was also performed for the same reason as for employees.

Assets: Assets in thousands of euros. As in previous variables, the dissimilarities in the sizes of the SMEs called for logarithmic transformation.

With_ERP: A dummy variable to indicate every year that enterprise use an ERP system. If a company implemented an ERP in 1999, this variable has a value equal to 0 for years 1997 and 1998; but has a value equal to 1 for years 1999 until 2005.

Micro_Emp: A dummy variable to indicate if enterprise is micro (value equal to 1) according it number of employees or not (value equal to 0).

Small_Emp: A dummy variable to indicate if enterprise is small (value equal to 1) according it number of employees or not (value equal to 0).

Medium_Emp: A dummy variable to indicate if enterprise is medium (value equal to 1) according it number of employees or not (value equal to 0).

Micro_Inc: A dummy variable to indicate if enterprise is micro (value equal to 1) according it incomes or not (value equal to 0).

Small_Inc: A dummy variable to indicate if enterprise is small (value equal to 1) according it incomes or not (value equal to 0).

Medium_Inc: A dummy variable to indicate if enterprise is medium (value equal to 1) according it incomes or not (value equal to 0).

We use two different panels data to validate our hypotheses. For hypothesis H1 the panel data is organized as follows:

$$Ln(Emp_{it}) = \alpha i + \beta_1 Ln(EmpCosts_{it}) + \qquad (1)$$
$$\beta_2 With\_ERP_{it} + \beta_3 Micro\_Inc_{it} +$$
$$\beta_4 Small\_Inc_{it} + \beta_5 Medium\_Inc_{it}$$
$$+ \varepsilon_{it}$$

In this case, the SMEs are the observational units (i = 1, 2, ..., 168) for the cross-sectional part of the model. Time series of the natural logarithm of the number of employees (Emp) were used as a dependent variable. The natural logarithm of personnel costs (EmpCosts) and a set of dummy variables to indicate every year that enterprise use an ERP system (With_ERP) and the size of each enterprise according its incomes (micro, small or medium) were used as independent variables.

For hypothesis H2 the panel data is organized as follows:

$$Ln(EmpCosts_{it}) = \alpha i + \beta_1 Ln(Inc_{it}) + \qquad (2)$$
$$\beta_2 Ln(Assets_{it}) + \beta_3 With\_ERP_{it} +$$
$$\beta_4 Micro\_Emp_{it} + \beta_5 Small\_Emp_{it}$$
$$+ \beta_6 Medium\_Emp_{it} + \varepsilon_{it}$$

In this case, the SMEs are the observational units (i = 1, 2, ..., 168) for the cross-sectional part of the model. Time series of the natural logarithm of the personnel costs (EmpCosts) were used as a dependent variable. The natural logarithm of incomes (Inc), the natural logarithm of assets (Assets) and a set of dummy variables to indicate every year that enterprise use an ERP system (With_ERP) and the size of each enterprise according its number of employees (micro, small or medium) were used as independent variables.

According to Arellano and Bover (1990), the supposition whether effects are fixed or random is not an intrinsic quality of the specification. In fact, the individual effects may be considered always random without loss of generality. Treating the effects as fixed or randomized makes no difference when T is large, because both Least Square Dummy Variable (LSDV) estimator and the generalized least-squares estimator becomes the same estimator. In fact, when T is finite and N is large, whether to treat the effects as fixed or random is not an easy question to answer (Hsiao, 2003).

Statistically, fixed effects models always give consistent results, but they may not be the most efficient model to estimate. Random effects will give you more accurate p-values as they are a more efficient estimator, so you should run random effects if it is statistically justifiable to do so. In our panel data models, we have some variables that are constant over time but vary between cases (like dummy variables related with Enterprise size), and others are fixed between cases but vary over time (like incomes and number of employees); hence, we should include both types by using random effects.

3.3 Data Collection

During the data collection process, the first step consisted in the analysis of the type of ERP system implemented. After looking for information on the main ERP vendors and implementations in Spain, we selected the top ERP vendor in Spain because its ERP system had a huge penetration in SMEs from the very beginning; hence, there are many enterprises that have used it for a long time. This characteristic allowed us to obtain more years to analyze the impact of the ERP system in SMEs number of employees and personnel costs. Furthermore, this ERP vendor agreed to provide us its database of SME customers.

We have collected an original sample of 310 Spanish enterprises which have implemented this ERP system since 1997 till 2005. Using SABI database (a database that contains legal reports on nearly 900,000 Spanish enterprises, many including detailed historical annual accounts, financial ratios, ownership and subsidiaries); we obtained public data between year 1997 and year 2005 about these enterprises, like number of employees, personnel costs, operation revenues and so on. Then, we have selected a sub-sample of SMEs that we obtained all data required during the sample period defined because neither their ERP implementations have happened at the same time, nor their reports of public data available were equally complete. With these criteria, the number of SMEs was reduced to 168 enterprises (see Table 1).

Table 1: Statistics of the sample used.

Year	ERP used by year	ERP accum. by year	Years of implem.	Ln (Emp) Aver.	Ln (EmpCosts) Aver.
1996	1	1	9		
1997	7	8	8	4.27	7.33
1998	14	22	7	4.27	7.49
1999	21	43	6	4.35	7.63
2000	27	70	5	4.42	7.77
2001	21	91	4	4.53	7.87
2002	23	114	3	4.61	7.97
2003	33	147	2	4.61	8.07
2004	21	168	1	4.65	8.12
2005	0	168	0	4.65	8.16

We can see that number of employees and personnel costs increase each year rather than diminish. For this reason, we divided our sample according to enterprises' size to verify whether the behavior is identical in each case and to avoid the mistakes which arise when SMEs of different sizes are evaluated together. In this sense, we used the EU classification of SMEs to organize and classify our sample. According to this classification we show our sample composition in Table 2.

Table 2: Companies by Number of Employees.

	(1b)	(2b)	(3b)	>50 M€	Total	%
(1a)	4	1	0	0	5	3
(2a)	3	18	14	0	35	21
(3a)	0	12	81	11	104	62
>= 251 emp.	0	0	8	16	24	14
Total	7	31	103	27	168	100
%	4	19	61	16	100	

(1a): Micro Enterprises between 1 and 10 employees
(2a): Small Enterprises between 11 and 50 employees
(3a): Medium Enterprises between 51 and 250 employees
(1b): Micro Enterprises with incomes until 2 M€
(2b): Small Enterprises with incomes between 2 and 10 M€
(3b): Medium Enterprises with incomes between 10 and 50 M€

4 PRELIMINARY FINDINGS

4.1 Employee Analysis

In this section, we analyse the evolution of the number of employees and personnel costs in our SME sample. If we consider the results per year, we cannot isolate the effect that has each ERP implementation because all the SMEs did not implement and use an ERP in the same year.

To better understand our sample and explain the behavior of SMEs according to their size, we analyzed SMEs categorized by the EU ranking classification.

Figure 1 represents the employees' evolution according to the obtained incomes by year.
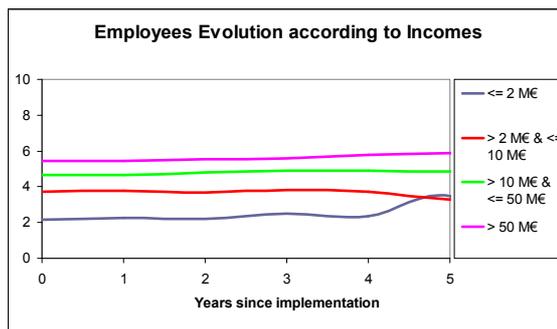

Figure 1: Natural logarithm of employees' number evolution for ERP adopters according to Incomes in EU ranking for SMEs, by years since implementation.

Figure 2 shows the personnel costs evolution according to the SME size by number of employees.
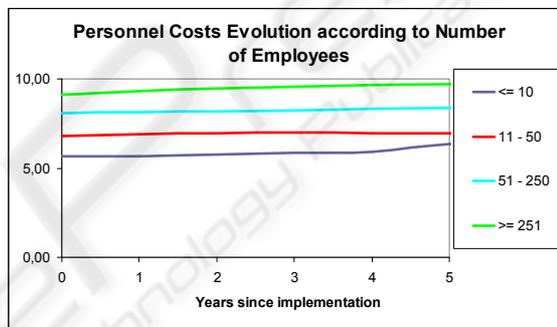

Figure 2: Natural logarithm of personnel costs evolution for ERP adopters according to Number of Employees in EU ranking for SMEs, by years since implementation.

If we compare the results since ERP implementation year with the last year evaluated, we note that the evolution of all categories is similar and they tend to diminish. Nevertheless, the unique exception is the last category that shows a slight tendency to increase after five years of ERP implementation year. This phenomenon can be justified by the fact that last category corresponds to medium enterprises with better incomes in our sample. This kind of SME has the need to grow for being able to continue increasing their benefits and the only way is contracting specialized employees in important areas of their business. Therefore, it is possible that some medium enterprises have recruited consultants from their partners in ERP implementation because only these SMEs can offer better salaries to specialized people. In this sense, it is important to highlight that these preliminary findings show that the increase or decrease of number of employees will depend on SMEs size.

4.2 Panel Data Findings

For the hypothesis H1 testing, we use the first panel data model. Table 3 shows the estimated panel data values using random effects.

Table 3: Panel Data Analysis using Random Effects to evaluate the ERP impact on number of employees.

	Random Effects			
Variable	Coef.	Std. Error	z	Prob>|z|
Ln(EmpCosts)	0.8018913	0.0173561	46.20	0.000
With_ERP	-0.1067177	0.0173789	-6.14	0.000
Micro_Inc	-0.8371361	0.1518015	-5.51	0.000
Small_Inc	-0.4314143	0.0933836	-4.62	0.000
Medium_Inc	-0.1751324	0.073455	-2.38	0.017
Constant	-1.537214	0.1634938	-9.40	0.000

In this model we obtain a significant overall R-squared = 0.8750 with a p-value = 0.0000. The natural logarithm of personnel costs, the dummy variable to indicate when the SME uses an ERP system and the dummy variables related with the size of each SME according its incomes (micro, small or medium) were found to be significant at the 0.05 level.

The dummy variables With_ERP, Micro_Emp, Small_Emp and Medium_Emp have different negative coefficients. Micro enterprises have a coefficient value that is approximately a double of small ones and five times of medium ones. Therefore, SMEs size according to their incomes has a negative impact in the number of employees. As expected, the findings support the hypothesis H1; hence, they suggest that the ERP implementation and usage has a little negative impact in the number of employees. Moreover, the evidence in Table 3 shows that this impact depends on the SME size.

For the hypothesis H2 testing, we use the second panel data model. Table 4 shows the estimated panel data values using random effects.

Table 4: Panel Data Analysis using Random Effects to evaluate the ERP impact on personnel costs.

	Random Effects			
Variable	Coef.	Std. Error	z	Prob>|z|
Ln(Incomes)	0.4036251	0.0193436	20.87	0.000
Ln(Assets)	0.3329367	0.0232169	14.34	0.000
With_ERP	0.1315715	0.0178684	7.36	0.000
Micro_Emp	-1.357411	0.2549366	-5.32	0.000
Small_Emp	-1.142593	0.1397028	-8.18	0.000
Medium_Emp	-0.5155082	0.1158403	-4.45	0.000
Constant	1.213851	0.2254311	5.38	0.000

In this model we obtain a significant overall R-squared = 0.7340 with a p-value = 0.0000. The natural logarithm of incomes, the natural logarithm of assets, the dummy variable to indicate when the SME uses an ERP system and the dummy variables related with the size of each SME according its number of employees (micro, small or medium) were found to be significant at the 0.05 level.

The dummy variable With_ERP has a positive coefficient whereas Micro_Emp, Small_Emp and Medium_Emp have different negative coefficients. Micro enterprises have a coefficient value that is approximately a 20% higher than small ones and a 250% of medium ones. Therefore, the size of SMEs according number of employees has a negative impact in their personnel costs. In this case, the findings contradict hypothesis H2, because they suggest that the implementation and use of an ERP system has a little positive impact in personnel costs; hence, ERP implementation and usage in SME suggests an increment in personnel costs. However, the evidence in Table 4 supports that ERP impact on personnel costs depends on the SME size.

5 CONCLUSIONS AND FURTHER WORK

Our preliminary results show that after an ERP implementations, there is a tendency in SME to decrease the number of employees but it depends on the SME size, as bigger the SME as lower will be the decrease in its number of employees. This result is interesting because data obtained from Spanish National Institute of Statistics shows an increase every year in the economically active population by business sector. However, according our findings, SMEs using an ERP system show a reduction in their number of employees. On the other hand, ERP implementation and usage are positively associated with personnel costs. This trend to increase personnel costs can be explained in the sense that SMEs that use ERP systems need people not only with specific operational skills but also with a very holistic approach and with more managerial skills to understand and obtain maximum benefits with the ERP system.

To better understand these results, we will attempt to conduct case studies and interviews with a representative sub-sample of SMEs, considering not only SMEs size but also their business sector. Moreover, a further research should analyze the

correlation between business sector (e.g. production, service, retail) and the obtained results.

One of the limitations of this study is that we did not divide employees by role (e.g. marketing, accounting, administrative, IT personnel, etc.). The main reason is that the legal information provided by SMEs is the total number of employees by company. SMEs are reluctant to provide the information disaggregated and, in some cases, they don't know the historical evolution of their employees. Also, and due to some legal benefits, employees are categorized in general personnel categories that not always fit with the real function/role within the company especially when SMEs elaborate the payroll and assign personnel costs to a certain area. But, we will try to obtain the disaggregated information at least for IT and administrative personnel since it seems that empirically these are the roles more affected by ERP adoptions not only in terms of number of employees but also in terms of personnel costs.

Future work should compare these findings with other similar studies of SMEs in other countries that have implemented ERP systems. Nevertheless, ERP systems do not seem to affect equally all SME' areas.

Hopefully, the results of this study will have an impact on the customers' strategies of ERP vendors and consultants, but also in the understanding of ERP business benefits and their perception from the different ERP stakeholder' viewpoints. The results may help to improve the understanding of ERP success and satisfaction levels (expected and perceived) from the ERP stakeholders. Currently, we are in contact with some ERP vendors to extend our sample to other SMEs and other ERP system to analyze if these findings can be generalized to all ERP systems. Furthermore, we only consider for this study the core ERP modules (FI/CO, MM/SD and HR) and we will attempt to analyze the impact of the extended ERP modules (e.g. CRM, SCM) in SMEs.

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