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Analyzing SMEs Size as a Moderator of ERP Impact in SMEs Productivity

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ABSTRACT

Enterprise Resource Planning (ERP) vendors have emphasized a positive impact of their ERP projects in enterprise 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, there is a lack of research studies on ERP impact in Small and Medium Enterprises (SME). Based on Cobb-Douglas production function, this paper attempts to analyze the impact of ERP implementations in SMEs' productivity. We have collected data from 168 Spanish SMEs during the period 1997-2005, concerning the type of purchased ERP, implementation period, number of employees and some financial indicators. We use a cross-sectional and time-series model to compare and analyze the SMEs' productivity evolution, before and after ERP implementations considering SMEs size as a critical variable to determine the level of productivity reached. Our preliminary findings suggest that SMEs size moderates ERP impact in their productivity. Therefore, researchers and practitioners should not consider all SMEs in the same package and they should have different strategies and approaches to obtain the best results in each ERP implementation.

INTRODUCTION

One of the main trends in ERP world, both in research and business, is the analysis of ERP impact obtained from this complex and in some cases costly implementations. According to Esteves and Bohórquez (2007), most of the research studies about ERP impact has been in the form of individual case studies, while experiences on the field of Small and Medium-sized Enterprises (SMEs) often fail in recognizing the economic and organizational impacts related to their ERP implementation and use.

Khurana and Lippincott (2000) mentioned that the potential performance improvements area is greater for relatively unhealthy large firms because large financially healthy enterprises are more efficient and effective in their industries. Subsequently, Mabert et al. (2000) found that ERP implementation costs, as a percent of revenue, range from 0.82% for very large firms to 13.65% for very small firms. One reason could be that there are economies of scale working in favor of the larger firms. However, the demand of ERP systems in SMEs has multiplied in recent years (Van Everdingen et al. 2000). At the same time, ERP vendors have started to develop specific products for this market because the differences between SMEs and large companies are recognized in existing literature (e.g. Bernroider & Koch 2001). Furthermore, most of previous research studies consider company size only as a factor of adoption process (e.g. Buonanno et al. 2005) and they do not consider SMEs size as a moderator of ERP impact.

In terms of methodology impact, Alpar and Kim (1990) note that methodology used to assess IT impacts can also significantly affect the results, especially when the findings are only calculated for a cross-section of the data. For this reason, we use a cross-sectional and time-series model to compare and analyze the SMEs' productivity evolution, before and after ERP implementations.

This paper is structured as follows. First, we analyze previous related literature. Next, we propose a theoretical model and some hypotheses. Then, we describe the research methodology. Finally, we present the preliminary findings and we draw some conclusions and further work.

LITERATURE REVIEW

ERP Overview

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

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. Wieder et al. (2006) mention that ERP imposes its logic on organizations and it forces employees to think in terms of integrated processes and to change the way they do accounting, production and control, etc. Even bigger costs are incurred in employee retraining and management time spent redesigning business processes. However, at the end, the organization has a new system with lasting value – it owns a new asset. This asset does not show up on an organization's balance sheet but exists and complements IT investments (Brynjolfsson & Hitt 1998). According to Sircar et al. (2000), both IT and corporate investments have a strong positive relationship with sales, assets, and equity, but not with net income. Moreover, the full expression of the potential integration of ERP systems is drastically limited by their functionally-oriented implementation. The worse consequence of this kind of implementation is the simple automation of the existing procedures without considers whether they can be improved (Beretta, 2002). Another point of view suggests that when firms implement ERPs, they need to redesign their business processes so that the information flows smoothly within organizations. Firms cannot obtain expected returns from ERP investments unless these changes are effectively managed after ERP systems are put into operation (Lee & Lee, 2004).

The question whether an ERP affects enterprises productivity was treated by previous approaches that identified non-financial performance measures since investment decision making remains a complex management process due to the scope and magnitude of interacting variables, which cannot always be quantified in financial terms. In general, IT could be used to impact the strategic position of the firm by enhancing quality of products and services to meet customer expectations in products and services (Bhatt, 2000; Beretta, 2002; Irani, 2002). The accounting discipline recently has come up some studies which provided evidence of ERP economic impacts (Poston & Grabski, 2001; Nicolaou et al., 2003; Matolcsy et al., 2005). These research studies found some evidence of immediate or delayed increases in firm performance after ERP adoptions, but the identified increases in performance are only in very few indicators. However, in contrast with previous authors which consider a recovery period of about two years, Wieder et al. (2006) suggest that firms recover their investment in approximately four to five years after the ERP implementation. One of the explanations for the absence of a positive impact on firm performance in the shorter run is that costs of ERP investments tend to exceed short and medium-term productivity increases (Dehning & Richardson, 2002).

Some empirical studies show little financial gains associated with ERP implementations. 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) test whether successful IT projects lead to a superior financial performance compared with ineffective IT projects. Their findings reveal that the successful IT investments entail superior financial performance for 3 or 4 years. However, the superior financial performance is short-lived. Another point of view is provided by Poston and Grabski (2001), they examined the ERP impact on firm financial performance during an analysis window 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 a subsequent study, Hunton et al. (2003) made a comparative analysis of the financial performance of ERP adopters and non-ERP adopters. Firm performance was measured over a 3 year time frame. The results showed that the financial performance of non-adopters declined in time whereas with adopters remained at an approximately constant level. The results also pointed to some efficiency benefits measured as Asset Turnover. 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 that of less successful ERP adopters, because the asset utilization and the business processes efficiency are superior for the former group of enterprises. Thus, the question about ERP impact still remains unanswered.

Cobb-Douglas Productivity Model

In previous works related with IT productivity impact, different production functions have been used to relate output to several inputs including IT. Furthermore, production functions were amplified by introducing other parameters like time trends and innovation changes (Haynes & Thompson, 2000), lagged variables (Brynjolfsson & Hitt, 2003), and so on. Moreover, Haynes and Thompson (2000) highlight that in case of service production, balance sheet measures for output and inputs (e.g. earning assets, liquid assets) were used instead of physical amounts.

Recent studies have employed the Cobb-Douglas production function (Cobb & Douglas 1928) because it is the simplest form that enables calculation of the relevant quantities of interest without introducing so many terms that the estimates are imprecise (Brynjolfsson & Hitt, 2003). On the other hand, the economic theory of production places certain technical constraints on the choice of functional form, such as quasi-concavity and monotonicity (Varian 1992). In these regards, the simplest functional form that relates inputs to outputs and is consistent with these constraints is the Cobb-Douglas specification, variants of which have been used since 1896 (Berndt 1991).

According to Brynjolfsson and Hitt (1996), the principal restriction implied by the Cobb-Douglas form is that the elasticity of substitution between factors is constrained to be equal to -1. This means that as the relative price of a particular input increases, the amount of the input employed will decrease by a proportionate amount, and the quantities of other inputs will increase to maintain the same level of output. As a result, this formulation is not appropriate for determining whether inputs are substitutes or complements. However, Gurbaxani et al. (2000) indicate that their findings provide strong justification for the use of the Cobb-Douglas production function in studies of information systems production conducted at the firm level.

THEORICAL MODEL AND HYPOTHESES DEVELOPMENT

SMEs size (number of employees and incomes) was investigated according to the current definition of European Union (EU) that classifies SMEs in three main categories:

- Micro enterprises are defined as enterprises which employ fewer than 10 persons and whose annual turnover or annual incomes does not exceed 2 million euro.
- Small enterprises are defined as enterprises which employ fewer than 50 persons and whose annual turnover or annual incomes does not exceed 10 million euro.
- Medium enterprises are defined as enterprises which employ fewer than 250 persons and whose annual turnover or annual incomes does not exceed 50 million euro.

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

When SMEs implement and use an ERP, the impact in their productivity is moderated by SMEs size?

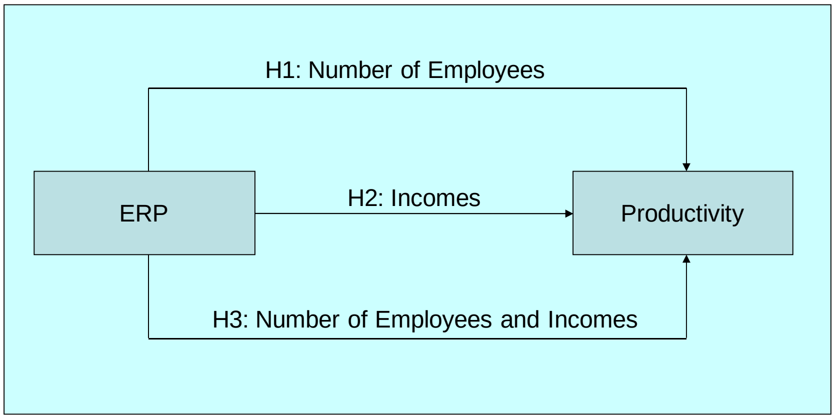
H1: The number of employees moderates ERP impact in SMEs productivity.

H2: The incomes moderate ERP impact in SMEs productivity.

H3: The number of employees and incomes moderate ERP impact in SMEs productivity.

Figure 1 shows how the SME productivity after ERP implementation is moderated by the number of employees and/or the incomes of each SME.

Figure 1: Theoretical model.



RESEARCH METHODOLOGY

As identified in the literature review and previous research studies, ERP productivity is intrinsically associated with the time dimension. Thus, we have collected data from SMEs in a period range that would include some years previous to the ERP implementation and some years after the ERP implementation. For data analysis, we have used a panel data approach.

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 approach 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).

According to Hsiao (2007), there are some considerations when using panel data approach:

- The collection of panel data is obviously much more costly than the collection of cross-sectional or time series data. However, panel data have become widely available in both developed and developing countries.

- Assuming that the impacts of observable variables are the same across individuals and over time, represented by the structure parameters, the incidental parameters represent the heterogeneity across individuals and over time that are not captured by observable variables. The challenge of panel methodology is to control the impact of unobserved heterogeneity, represented by the incidental parameters, to obtain valid inference on the structural parameters.

Arellano and Bover (1990) argue that 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 (GLS) 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 SME 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.

The main advantage of random effects specification over the fixed effects one is that the number of parameters stays constant when sample size increases. Therefore, it allows the derivation of efficient estimators that make use of both within and between (group) variations. In addition, it allows the estimation of the impact of time-invariant variables that is impossible in the fixed effects approach. The disadvantage is that one has to specify a conditional density of individual specific effects, while they are unobservable. However, if these effects are correlated with the observable variables or if there is a fundamental difference among individual units, the dependent variables cannot be viewed as a random draw from a common distribution; hence, common random effect model is misspecified and the resulting estimator is biased (Hsiao, 2007).

Productivity Model

As previously explained, most of the studies are using Cobb-Douglas productivity model to analyze IT productivity issues. In our research, we have used the translog production function because it allows the 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 extend the results and because they will be statistically consistent (Shu & Strassmann, 2005).

The instrumentation and metrics of the variables are the following:

Prod: The productivity of 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.

Inc: Incomes (annual turnover) in thousands of Euros. Logarithmic transformation was also performed for the same reason as for productivity.

Emp: The number of employees to the SMEs. 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 SME use an ERP system. If SME have 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, Small_Emp, Medium_Emp: Dummy variables to indicate if SME is micro, small or medium depending on its number of employees. Only one of them has a value equal to 1, while the others are 0.

Micro_Inc, Small_Inc, Medium_Inc: Dummy variables to indicate if SME is micro, small or medium depending on its incomes. Only one of them has a value equal to 1, while the others are 0.

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

$$Ln(Prod_{it}) = \alpha_i + \beta_1 Ln(Prod_{it-1}) + \beta_2 Ln(Inc_{it}) + \beta_3 With\_ERP_{it} + \beta_4 Micro\_Emp_{it} + \beta_5 Small\_Emp_{it} + \beta_6 Medium\_Emp_{it} + \varepsilon_{it} \quad (1)$$

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 productivity (Prod) were used as a dependent variable. The natural logarithm of auto-regressive coefficient of order one (Prodt-1), the natural logarithm of incomes (Inc) 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.

For hypothesis H2 panel data is organized as follows:

$$Ln(Prod_{it}) = \alpha_i + \beta_1 Ln(Prod_{it-1}) + \beta_2 Ln(Emp_{it}) + \beta_3 With\_ERP_{it} + \beta_4 Micro\_Inc_{it} + \beta_5 Small\_Inc_{it} + \beta_6 Medium\_Inc_{it} + \varepsilon_{it} \quad (2)$$

In this equation, 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 productivity (Prod) were used as a dependent variable. The natural logarithm of auto-regressive coefficient of order one (Prodt-1), the natural logarithm of employees (Emp) 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 H3 panel data is organized as follows:

$$Ln(Prod_{it}) = \alpha_i + \beta_1 Ln(Prod_{it-1}) + \beta_2 With\_ERP_{it} + \beta_3 Micro\_Inc_{it} + \beta_4 Small\_Inc_{it} + \beta_5 Medium\_Inc_{it} + \beta_6 Micro\_Emp_{it} + \beta_7 Small\_Emp_{it} + \beta_8 Medium\_Emp_{it} + \varepsilon_{it} \quad (3)$$

In this equation, 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 productivity (Prod) were used as a dependent variable. The natural logarithm of auto-regressive coefficient of order one (Prodt-1) and a set of dummy variables to indicate every year that enterprise use an ERP system (With_ERP), the size of each enterprise according its incomes (micro, small or medium) and the size of each enterprise according its number of employees (micro, small or medium) were used as independent variables.

Data Collection

During the data collection process, the first step consisted in the analysis of the kind 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 enterprises from the very beginning; hence, there are many companies who use it for a long time. This characteristic allowed us to obtain more years to analyze whether SMEs size acts as a moderator of ERP impact in SMEs productivity. Furthermore, this ERP vendor agreed to provide 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 enterprise 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 productivity, number of employees, incomes and so on. Then, we have selected a sub-sample of SMEs that we obtained all required data during the defined sample period 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. Table 1 shows the number of SMEs that have implemented an ERP system and the evolution (in average) of productivity that decreases each year. These values of productivity were obtained from SABI with its own formula. Then, we have used the Cobb-Douglas production function to relate our interested inputs variables to these productivity results taking into account each SME and the time period to obtain the regression coefficients and see whether SMEs size (independent variable) moderates ERP impact in SME productivity (dependent variable).

Table 1: Statistics of the sample used.

Year	SMEs that implemented ERP in those year	Accumulated of SMEs that implemented ERP	Years of ERP implementation	Productivity average	Productivity standard deviation
1996	1	1	9		
1997	7	8	8	2,06	2,78
1998	14	22	7	2,05	2,55
1999	21	43	6	2,04	1,79
2000	27	70	5	1,86	1,06
2001	21	91	4	1,86	1,44
2002	23	114	3	1,82	1,27
2003	33	147	2	1,78	1,08
2004	21	168	1	1,88	1,54
2005	0	168	0	1,78	1,15

We have also divided our sample based on SMEs' 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. According to the EU classification, Table 2 shows our sample composition.

Table 2: SMEs by Number of Employees and Incomes.

	<= 2M€ (Micro)	Between 2M€ and 10M€ (Small)	Between 10M€ and 50M€ (Medium)	> 50M€	Total	%
Between 1 and 10 employees (Micro)	4	1	0	0	5	3%
Between 11 and 50 employees (Small)	3	18	14	0	35	21%
Between 51 and 250 employees (Medium)	0	12	81	11	104	62%
More than 250 employees	0	0	8	16	24	14%
Total	7	31	103	27	168	100%
%	4%	19%	61%	16%	100%	

RESULTS

Initially, we analyze the productivity evolution average in our SMEs sample. Then, we discuss the panel data findings. If we consider the results by year, we cannot isolate the effect that has each ERP implementation because all SMEs did not acquire and implement an ERP in the same year. Therefore, we have considered the ERP implementation year in each SME as year 0 and then we have considered the years before ERP implementation as negatives and years after ERP implementation as positives to be able to determine the real effect in each case.

Productivity Analysis

To avoid heteroscedasticity, we have expressed the obtained findings with a natural logarithm. Figure 2a represents the productivity evolution according to the number of employees.

Figure 2a: SMEs productivity evolution for ERP adopters based on their number of employees after ERP implementation.

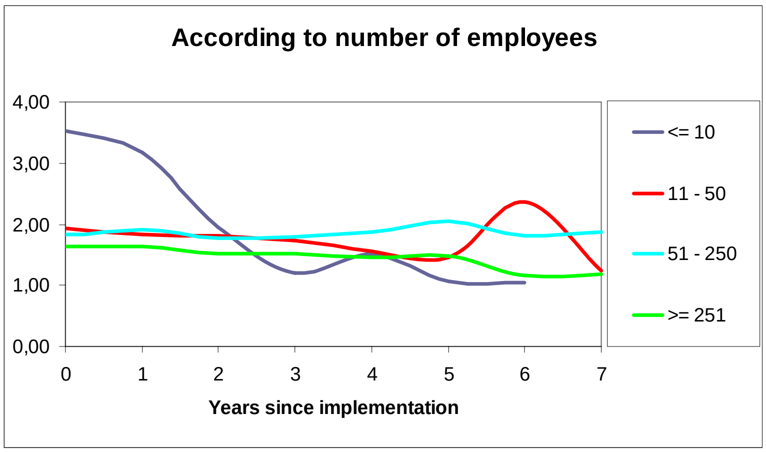


Figure 2a suggests that SME productivity varies based on its size because different groups have different trends.

Figure 2b shows the productivity trend according incomes.

Figure 2b: SMEs productivity evolution for ERP adopters based on their incomes after ERP implementation.

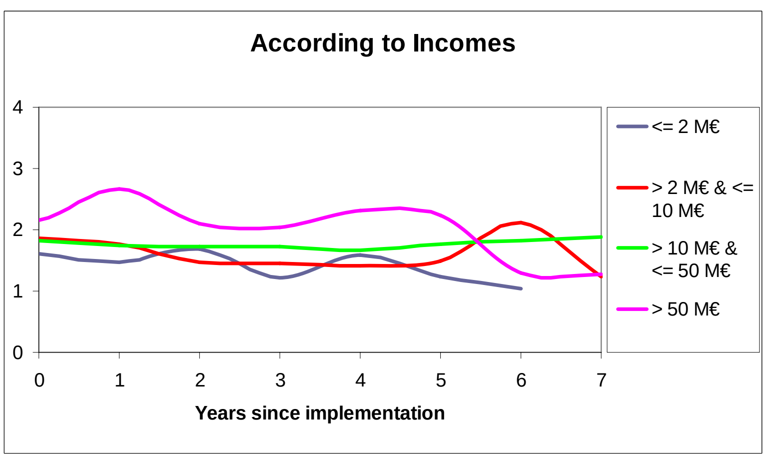


Figure 2b suggests that the productivity evolution trend of all SME categories varies according to SMEs size in a similar way than in Figure 2a.

Next, we present a more in depth analysis of productivity evolution using a panel data approach.

Panel Data Findings based on SMEs number of employees

For hypothesis H1 testing, we have used the first panel data model (see section 4.2). Table 3 shows the estimated panel data values using random effects.

Table 3: Panel Data Analysis using Random Effects based on SMEs number of employees.

	Random Effects			
Variable	Coef.	Std. Error	z	Prob>|z|
Ln(Prod$_{t-1}$)	0. 7673004	0.0160662	47.76	0.000
Ln(Incomes)	0.0638446	0.0095244	6.70	0.000
With_ERP	-0.0634552	0.0145516	-4.36	0.000
Micro_Emp	0.2946193	0.0589414	5.00	0.000
Small_Emp	0.1567667	0.030948	5.07	0.000
Medium_Emp	0.0928347	0.0225204	4.12	0.000
Constant	-0.5671641	0.1019783	-5.56	0.000

In this model we obtain a significant overall R-squared = 0.6933 with a p-value = 0.0000. All the independent variables were found to be significant at the 0.05 level.

The dummy variable With_ERP has a negative coefficient whereas Micro_Emp, Small_Emp and Medium_Emp have positive coefficients. Micro enterprises have a coefficient value that is approximately a double of small ones and a triple of medium ones. Therefore, the number of employees moderates ERP impact in SMEs productivity. As expected, the findings support hypothesis H1. However, these findings suggest that the ERP implementation and use has a small negative impact in SMEs productivity.

Panel Data Findings based on SMEs incomes

In this section, we analyzed the hypothesis H2 using the second panel data model (see section 4.2). We evaluated whether incomes moderates ERP impact in SMEs productivity. Table 4 shows the estimated values for this test using random effects.

Table 4: Panel Data Analysis using Random Effects based on SMEs incomes.

	Random Effects			
Variable	Coef.	Std. Error	z	Prob>|z|
Ln(Prod$_{t-1}$)	0. 7499068	0.0172823	43.39	0.000

Ln(Emp)	-0.0612368	0.0099524	-6.15	0.000
With_ERP	-0.0348722	0.0155329	-2.25	0.025
Micro_Inc	-0.2871796	0.0544204	-5.28	0.000
Small_Inc	-0.1739421	0.0326033	-5.34	0.000
Medium_Inc	-0.0873813	0.0226866	-3.85	0.000
Constant	0.519269	0.0626221	8.29	0.000

In this model we obtain a significant overall R-squared = 0.6869 with a p-value = 0.0000. All the independent variables were found to be significant at the 0.05 level.

In this case, the dummy variable With_ERP and other dummy variables (Micro_Inc, Small_Inc and Medium_Inc) have negative coefficients. Micro enterprises have a coefficient value that is approximately a double of small ones and a quadruple of medium ones. Therefore, the incomes moderate ERP impact in SMEs productivity. These findings support hypothesis H2 and they can explain the decrease of productivity in Figure 2b. As in the first panel data model, the ERP implementation and use has a small negative impact in SMEs productivity.

Panel Data Findings based on SMEs number of employees and incomes

Finally, we evaluated hypothesis H3 using the third panel data model (see section 4.2). In this case, we attempt to combine the effects produced by the size of SMEs, according to the number of employees and the incomes, to determine whether they together moderate ERP impact on SMEs' productivity. Table 5 shows the estimated values for all considered variables using random effects.

Table 5: Panel Data Analysis using Random Effects based on SMEs number of employees and incomes.

	Random Effects			
Variable	Coef.	Std. Error	z	Prob>|z|
Ln($Prod_{t-1}$)	0. 7784586	0.0162035	48.04	0.000
With_ERP	-0.0473317	0.0144153	-3.28	0.001
Micro_Inc	-0.2265522	0.0566936	-4.00	0.000
Small_Inc	-0.1232058	0.0309676	-3.98	0.000
Medium_Inc	-0.0696616	0.0234971	-2.96	0.003
Micro_Emp	0.228459	0.0655296	3.49	0.000
Small_Emp	0.1160624	0.0318074	3.65	0.000
Medium_Emp	0.0755842	0.0246099	3.07	0.002
Constant	0.1359381	0.0238786	5.69	0.000

In this model we obtain a significant overall R-squared = 0.6878 with a p-value = 0.0000. All the independent variables were found to be significant at the 0.05 level.

The dummy variable With_ERP and other dummy variables (Micro_Inc, Small_Inc and Medium_Inc) have negative coefficients, whereas Micro_Emp, Small_Emp and Medium_Emp have positive coefficients. For coefficients related with SMEs size based on their incomes, micro enterprises have a coefficient value that is approximately a double of small ones and a quadruple of medium ones. For coefficients related with SMEs size based on their number of employees, micro enterprises have a coefficient value that is approximately a double of small ones and a triple of medium ones. These overall results confirm previous findings; hence, support hypothesis H3. As in previous sections, the ERP implementation and use has a small negative impact in SMEs productivity.

DISCUSSION AND FURTHER WORK

Our preliminary findings show that the behavior of SMEs productivity trend is moderated by SMEs after ERP implementation and use. However, while the first panel data model, related with the SMEs number of employees has a positive impact on SMEs productivity; the second panel data model, related with the SMEs incomes, has a negative impact on SMEs productivity. The third panel data model shows the interaction between incomes and number of employees and if we compare it with the results obtained in the two previous panel data models, they are consistent. These results suggest that there are strong and very complex relationships among considered variables within SMEs size; while in panel data models the number of employees contributes positively in the SMEs productivity, the incomes has the contrary effect. Furthermore, we found that ERP implementation and use affects negatively SMEs productivity.

The obtained results are interesting because they confirm that the size matters and it moderates the ERP impact in SMEs productivity. Therefore, researchers and practitioners should not consider all SMEs in the same package and they should have different strategies and approaches to obtain the best result in each ERP implementation.

Additionally, we have contributed to the current ERP research literature by applying a panel data approach to improve the understanding of SMEs size as a critical variable in ERP adoption.

Implications for researchers and practitioners

The panel data analysis suggests that the ERP implementation and use has a little negative impact in SMEs productivity, which reinforces the IT productivity paradox (Brynjolfsson 1993) and suggests that this topic need more in depth studies. Eventually, we also expect promising methodological advances in the way IT value should be measured as discussed in the IT productivity paradox beyond the arguments brought forward so far. Wagner et al. (2006) suggest that their empirical work on IT business alignment and IT value indicates that the available statistical methods as especially structural equation modeling might have a limited explanatory power as they rest upon the assumption of ultimately linear relations between endogenous and exogenous variables while the real world might rather exhibit multiplicative relations, as has been captured by production functions in non-IT areas for a century. Thus, the development of an IT production function might be a quite relevant and interesting area for IS research.

From a practitioner perspective, the results of this study will have an impact not only on the customers' strategies of ERP vendors and consultants, but also on the knowledge of ERP impact and on the perception from the different ERP stakeholders' viewpoint. The results may help to improve the understanding of ERP success and satisfaction levels (expected and perceived) from an ERP stakeholder perspective. Furthermore, practitioners should be aware that ERP systems may not have a direct impact on productivity but on enterprise processes, organizational integration and standardization, and decision making process effectiveness.

Further research

As future work, we will attempt to compare these findings with similar studies of SMEs in other countries that have implemented ERP systems. The results could be used to improve the understanding of SMEs' behavior according SMEs size. Moreover, to validate these results we will conduct case studies and interviews with a representative sample of SMEs. Currently, we are in contact with other Spanish SMEs and also with other ERP vendors to extend our sample to other ERP systems.

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