Impact of Information Technology investments on firm productivity in peripherals countries: The case of Portugal

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Abstract
IS/IT investments are seen has having an enormous potential impact on the competitive position of the firm, on its performance, and demand an active and motivated participation of several stakeholder groups.
The shortfall of evidence concerning the productivity of IT became known as the 'productivity paradox'. As Robert Solow, the Nobel laureate economist stated "we see computers everywhere except in the productivity statistics".
An important stream of research conducted all over the world has tried to understand these phenomena, called in the literature as «IS business value» field. However there is a gap in the literature, addressing the Portuguese situation. No empirical work has been done to date in order to understand the impact of Information Technology adoption on the productivity of those firms.
Using data from two surveys conducted by the Portuguese National Institute of Statistics (INE), Inquiry to the use of IT by Portuguese companies (IUTIC) and the Inquiry Harmonized to (Portuguese) companies (accounting data), this study relates (using regression analysis) the amounts spent on IT with the financial performance indicator Returns on Equity, as a proxy of firm productivity, of Portuguese companies with more than 250 employees.
The aim of this paper is to shed light on the Portuguese situation concerning the impact of IS/IT on the productivity of Portuguese top companies.
Empirically, we test the impact of IT expenditure on firm productivity of a sample of Portuguese large companies.
Our results, based on firm-level data on Information Technology expenditure and firm productivity as measured by return on equity (1186 observations) for the years of 2003 and 2004, exhibit a negative impact of IT expenditure on firm productivity, in line with "productivity paradox" claimants.

Keywords: Information Technology investments, Firm Productivity, Return on Equity.

JEL Classification: M10, M15, M20, O30.

1 Introduction

The introduction of information systems/information technology (IS/IT) in organizations is likely to have a significant impact within the organization. IS/IT can be used in restructuring organizational activity, in strengthening the competitive position of the firm (Ward & Peppard, 2002), and to transform entire business processes (Al-Mudimigh et al 2001; Brynjolfsson & Hitt, 1998).

In the 1980s IS/IT was herald as a key to competitive advantage (McFarlan, 1984; Porter & Millar, 1985). Porter and Millar (1985) concluded that IS/IT has affected competition in three ways: it has led to changes in industry structure and competition, it was used to support the creation of new business, and companies using IT outperformed their competition. Earl (1989) suggests that IS/IT has the potential to be a strategic weapon in at least four ways: to gain competitive advantage, to

improve productivity and performance, to enable new ways of managing and organizing and to develop new business.

In peripherals countries, as the case of Portugal, IS/IT can play a central role, bringing companies to the centre of international markets and reducing the distance barriers to the capability to connect with suppliers, customers and potential investors.

Despite increasing expenditure on IS/IT (Ballantine & Stray, 1999; Ryan & Gates 2004, Willcocks & Lester 1999) and the belief that IT has a significant impact on organizational performance (Osey-Bryson & Ko, 2004), the effect of such investments on firm productivity has been unclear (Dasgupta.et al., 1999; Farbey et al. 1999) and has given rise to a 'productivity paradox' (Love & Irani, 2004). Many organizations find themselves in a "Catch 22", for competitive reasons they cannot afford not to invest in IS/IT, but economically they cannot find sufficient justification for it (Willcocks 1992).

During the past four decades a great deal of attention has focused on the impact of IT investment. However studies have frequently generated controversial or inconsistent results. Several empirical studies have failed to find any positive relationships between extensive use of IS/IT and organizational efficiency, performance and success (Kivijärvi & Saarinen, 1995).

Given the large amount spent by organizations on IS/IT investments, it is important to understand the impact of those investments in the profitability of the firm. While there is an extensive work done worldwide, there is a gap in the literature concerning the Portuguese situation. Martins & Raposo (2005) have done a first attempt to investigate the relationship between Portuguese firm's productivity and spending on computers, using a Cobb-Douglas production function, and found a positive elasticity output for computer capital at the firm level. Nevertheless, this research say nothing on the impact of those investments in the profitability of those companies.

The aim of this paper is to shed light on the relationship between IS/IT investments and firm financial performance of those companies, using the OLS model.

Next session provides a brief literature review in the IS business value field. Then data and the model are presented. After the discussion of the results, some conclusions are drawn and guidelines for future research presented.

2 Impact of IS/IT on Firm Performance

Firms today invest enormous resources in IS/IT with the hope of gaining significant returns, which will impact their performance. A growing body of research into the firm performance effects of IT investment has emerged and is sometimes referred to as IT business value research. The problem that researchers face is identifying robust methods to gain insight into how IT business value is created (Kauffman & Weill 1989).

Executives are strongly aware that IT systems have the potential to enable a firm to radically transform the way in which it does business and IT expenditures have increased accordingly. This is particularly true in the case of companies that operate from an peripheral country.

The crux of the problem is whether IT investment really makes a difference in firm performance.

Prior researchers have reached contradictory conclusions when studying the relationship between IT investment and firm performance.

The search concerning the impacts of IT investments has been conducted at several levels: (1) the economy as a whole, (2) the industry within an economy, (3) the firm within an industry, (4) a work group or division within a firm, (5) the individual or information system (Bakos 1987; Brynjolfsson & Yang, 1996).

The shortfall of evidence concerning the productivity of IT became known as the 'productivity paradox'. As Robert Solow, the Nobel laureate economist stated "we see computers everywhere except in the productivity statistics (in Brynjolfsson 1992: 2).

Brynjolfsson & Yang (1996) identified four reasons to explain the existence of the paradox: (1) measurement errors, (2) lags, (3) redistribution, and (4) mismanagement of IT investments.

Differing definitions of information technology investment also contribute to the contradictory findings (Cline & Guynes 2001). For the purpose of this paper, the concept of IS/IT investment is closed to the concept defined by the MIT researchers Aral & Weill (2006: 23): "total expenditures on IT (all computers, software, data communications, and people dedicated to providing IT services), including both internal and outsourced expenditures".

The early studies tended to address the question of computer use (Lucas 1975) and the relationship between performance and computerization intensity (Cron & Sobol 1983). The studies by PIMS (1984) and Bender (1986) measured the proportion of expenses dedicated to IT in firms, while Breshniham (1986) and Roach (1987) measured amounts of resources dedicated to IT in a sector.

The difficulty of identifying interesting, consistent results is further compounded by the use of inconsistent definitions of key input and output variables. "IT expenditures" is a good example: some studies adopted a narrow definition of just IS expenses; others broadened the definition to include communications, software and hardware-related employees, and managers.

Early work in the field is based on some notion of productivity drawn from accounting (which basically ignore the process by which inputs are converted into outputs) or on methodologies from economics. In this case the process that links inputs to outputs is modelled, but very simply using computed ratios of input to output transformation (Crowston & Treacy, 1986).

Empirical studies, without a strong theory-base, hardly will reveal the heart of the IT pay-off question. In the view of Crowston & Treacy (1986) we must look for a strong theory about the process in organizations to guide our choice of variables and to generate testable hypothesis about them. Without a theory, we will be faced with far too many possible input or output variables and no way to control for the many interactions between them.

Once we have chosen a reference discipline and thus our variables of interest, we can borrow accepted definitions and well tested methodologies to more systematic and valid studies.

Once a theory base and methodology have been chosen and the unit of analysis has been decided upon to measure IT impact and its locus, the next logical step in the progression is to select a set of performance measures (Kauffman & Weill 1989). With respect to performance measures, at firm level, we can find two sets of measures: accounting based measures (ROA, ROE, ROI, ROS) and market measures (as Tobin's q).

The study of Lucas (1975) on the relation among the use of an accounting information system, action, and organizational performance was inconclusive. Cron & Sobol (1983) found that the firms making extensive use of computer software were most likely to be either extremely high or low performers. Bender (1986) found an optimal level of IT expenses and argue that more or less IT expenses were associated with weaker performance. According Harris & Katz (1988) top performance firms IT expense accounted for higher proportion of total operating expense.

Kivijärvi & Saarinen (1995) concluded in their paper that IS investments were not related to superior financial performance of the firm in the short term, but was related with the maturity of IS, which in turn, was related to improved performance.

Stratopoulos & Dehning (2000) found that successful users of IT have superior financial performance relative to less successful users of IT, as measured by ROA, ROE and ROI. Hu & Plant (2001) found no statistical evidence that IT investments have caused the improvement of financial performance. Shin (2001) shows that IT does not directly improve financial performance, but in conjunction with

vertical disintegration and diversification, however, it does improve financial performance as measured by net profit, but not ROA and ROE. Aral & Brynjolfsson (2006) found that (ERP) purchase events are uncorrelated with performance while go-live events (effective use) are positively correlated.

Aral & Weill (2006) demonstrated that IT investment allocations and organizational IT capabilities drive differences in firm performance, firms' total IT investment was not associated with performance, but investments in specific IT assets explained performance differences along dimensions consistent with their strategic purpose.

As we can observe, the question of the impact of IS/IT investments on firm performance remains since the 1970's and even nowadays, it seems to be far from being a pacific theme.

The empirical work use mainly samples of USA or UK firms, sometimes with north European companies. Next section presents data from a sample of Portuguese firms, the selected variables and the research model. The purpose of the present paper is to conclude if the IS/IT investment of the top Portuguese companies impact on their profitability, as measured by ROE, or not.

3 Data Description and Empirical Model

3.1 Data Description

This section provides a brief description of the data used in this paper. The Portuguese National Institute of Statistics (INE) runs annually two surveys to Portuguese companies, the Harmonized Firm Survey (IEH) which collects accounting data, and the Survey on the Use of Information and Communication Technologies (IUTIC) where we can find information about IT expenditure.

Both surveys are exhaustive for firms with more than 250 employees (all population of Portuguese firms is inquired), so we have requested data on those companies, for the years of 2004 and 2005 (2004 was the first time in which the question "how much your company spent in IT" appeared in the IUTIC survey).

The sample is constituted by large firms with more than 250 employees mainly from the private sector and has a total of 1186 observations (581 firms inquired in 2004 and 605 in 2005) from the sectors of extracting and manufacturing industry (sector C/D), electricity (sector E), construction (sector F), wholesale and retail trading and repair (sector G), Hotels and Restaurants (sector H) transport and communications (sector I), real estate and business service activities (sector K) and other collective, social and personal activities (sector O).

Those firms employee 742 persons in average, spent 1726702 euros in advertising, 905895 euros with IS/IT and communications, and 547643 euros with human resources dedicated exclusively to IS/IT and communications. Table 1 and table 2 give us a brief statistical description to characterize the sample of Portuguese companies.

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Employees	1186	250	15075	880450	742,37	1133,044
Advertising (€)	1160	0	118253058	2002974583	1726702,23	6891162,598
Total Sales (€)	1186	938042	6239277478	147156822644	124078265,30	361372071,2
IT Assets (€)	1186	0	82940198	1074391880	905895,35	4884007,763
IT HR (€)	1186	0	49521319	649505325	547643,61	3278848,853
Valid N (listwise)	1160					

Table 1: Descriptive statistics of the independent and selected control variables

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ROE	1115	-1171,06	3352,52	6,7175	131,47537
Valid N (listwise)	1115				

Table 2: Descriptive statistic of the dependent variable ROE

Some companies (26) didn't give information on the amount spent on advertising. Others (71) did not provide enough accounting information to allow us to compute the return on equity financial performance indicator, or presented a negative value for equity, So we have 1115 valid observations.

3.2 Variables

The dependent variable, return on equity (ROE), was calculated by taking the net result over shareholders' equity for each specific year. ROE represents what return the company is making on the shareholders' funds invested in the company. ROE assesses leadership ability to get the job done. A business that has a high return on equity is said to be one that is capable of generating cash internally (Ross et all, 2002). ROE is one of the most common indicators used by IS researchers to study the impact of IS/IT investments on firm performance (Rai et All., 1997; Stratopoulos & Dehning 1999, 2000; Shin, 2001; Aral & Brynjolfsson, 2006), particularly when data sets include firms that are not present in the financial markets (publicly traded), or when the last ones are not efficient (it is not possible to use market measures).

As independent variable, we used IS/IT investment. The IS/IT investment concept is operationalized in many different ways by different researchers. In this paper we use the concept of IS/IT investment which is asked to Portuguese companies in the IUTIC survey. This concept is closed to the concept defined by the MIT researchers Aral & Weill (2006: 23): "total expenditures on IT (all computers, software, data communications, and people dedicated to providing IT services), including both internal and outsourced expenditures".

The Portuguese IUTIC survey provides us that data into two separate variables:

- IT_{Assets}= All expenses in computers, software, and data communications dedicated to providing IT services;
- IT_{HR}= Human Resources expenditure related to computers, software, and data communications dedicated to providing IT services;

The IS/IT investment variable will be the sum of both items.

In the model we divided these variables by total sales, in line with Aral & Weill (2006), with the aim of control for the relative production size of firms.

As control variables, two firm level variables were introduced to control for their effects on performance, advertising expenditures and firm size (Aral & Weill, 2006). According Montgomery & Wernerfelt (1988), advertising expenditures are positively related to firm performance. Firm size will be controlled by the natural logarithm (ln) of the nº of employees and advertising expenditures will be operationalized as ratio that expenses to sales, to control for the relative production size of firms (Aral & Weill, 2006). Also we will introduce p-1 control variables for the different sectors present in the sample (p=number of sectors).

3.3 Model

First we tested the model considering as independent variable (1), the total amount of IT expenditures, but the results were not statistically significant.

(1) $ROE=\beta_0+\beta_1(Total\ IT/Sales)+\beta_2 lnEmployees+\beta_3(Avertising/sales)+\beta_j Sector_j+\varepsilon_i$, where β_j represents the sector control variables.

Then, we had separated the IT variable in two other ones as described above, IT_{Assets} and IT_{HR}.

(2) $ROE=\beta_0+\beta_1(IT_{Assets}/Sales)+\beta_2 l(IT_{HR}/Sales)+\beta_3 lnEmployees+\beta_4(Avertising/sales)+\beta_j Sector_j+\varepsilon_i$

At last, and after drop an outlier observation in order to improve the degree of confidence, we compute the model (3) using just one sector control variable, for sector G, due to multicolinearity problems with the sector control variables in model (2).

(3) $ROE=\beta_0+\beta_1(IT_{Assets}/Sales)+\beta_2 l(IT_{HR}/Sales)+\beta_3 lnEmployees+\beta_4(Avertising/sales)+\beta_5 Sector_G+\varepsilon_i$

4 Results

We run the models using SPSS 15.0 statistical software package. The first model tested (2) did not presented autocorrelation problems (DW=1,991).

Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,125[a]	,016	,006	131,09831	1,991

a. Predictors: (Constant), Sector K, Sector E, Sector H, IT Assets/Sales, Advert/Sales (%), ln Employees, IT HR/Sales, Sector F, Sector I, Sector G, Sector C/D

b. Dependent Variable: ROE

Table 3: Model adjustment and Durbin-Watson test

As we can see from the table bellow, the model (2) is statistically significant at the 10% level.

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	299345,659	11	27213,242	1,583	,098[a]
	Residual	18957004,056	1103	17186,767		
	Total	19256349,715	1114			

a. Predictors: (Constant), Sector K, Sector E, Sector H, IT Assets/Sales, Advert/Sales (%), ln Employees, IT HR/Sales, Sector F, Sector I, Sector G, Sector C/D

b. Dependent Variable: ROE

Table 4: ANOVA

For a level of significance of 10%, the model presents, a negative impact of IT_{Assets} on return on equity, as others researchers found in early studies on IS business value. It is important to not forget that Portuguese economy as a gap of some years to the rest of OECD countries, and that some of the realities faced by Portuguese companies nowadays, were faced by others some years ago. In the years considered in the study, Portuguese economy has been under an economic recession.

It is interesting to notice that IT expenditure with human resources denotes a positive relation to ROE, however this effect lacks statistical significance.

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-16,504	53,880		-,306	,759
	IT Assets/Sales	-2,900	1,790	-,050	-1,620	,106
	IT HR/Sales	,064	1,025	,002	,063	,950
	ln Employees	3,883	5,870	,020	,661	,508
	Advert/Sales (%)	-,057	1,381	-,001	-,042	,967
	Sector C/D	-5,957	40,045	-,023	-,149	,882
	Sector E	3,202	50,330	,003	,064	,949
	Sector F	4,129	41,740	,009	,099	,921
	Sector G	29,797	40,895	,082	,729	,466
	Sector H	-8,422	46,952	-,010	-,179	,858
	Sector I	-22,136	41,773	-,048	-,530	,596
	Sector K	7,136	41,168	,018	,173	,862

a. Dependent Variable: ROE

Table 5: Parameter estimation

After removing an outlier (N=1114) and left only sector G control variable (in order to solve, some multicolinearity problems), the statistical significance of the model improve significantly.

The new model also does not present problems of autocorrelation, and it became significantly statistic for 95%.

Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,106[a]	,011	,007	84,76627	2,013

a. Predictors: (Constant), Sector G, IT HR/Sales, ln Employees, Advert/Sales (%), IT Assets/Sales

b. Dependent Variable: ROE

Table 6: Model adjustment and Durbin-Watson test

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	90571,998	5	18114,400	2,521	,028[a]
	Residual	7961334	1108	7185,320		
	Total	8051906	1113			

a. Predictors: (Constant), Sector G, IT HR/Sales, ln Employees, Advert/Sales (%), IT Assets/Sales

b. Dependent Variable: ROE

Table 7: ANOVA

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-24,734	23,371		-1,058	,290
	IT Assets/Sales	-2,915	1,143	-,077	-2,551	,011
	IT HR/Sales	,290	,659	,013	,440	,660
	ln Employees	4,409	3,720	,036	1,185	,236
	Advert/Sales (%)	,388	,876	,013	,443	,658
	Sector G	14,300	7,112	,060	2,011	,045

a. Dependent Variable: ROE

Table 8: Parameter estimation

The results reached in the previous model are confirmed in this one, and we can also find a positive contribution of sector G to ROE. In fact this sector, wholesale, retail trade and repair, is one of the most competitive Portuguese sectors, with some degree of internationalization mainly in Europe, and some of the most profitable Portuguese companies operate in this sector.

5 Conclusion and Future Research Agenda

We find a negative relation between IT expenditure and ROE. Our results are consistent with the conclusions researched by others IS business value researchers, namely those who rise the problem of the "productivity paradox". The fact that the expenditure with IT people have a positive relation with ROE is consistent with the ones that state that this is not IT that maters, but what people do with it.

It seems that Portuguese companies are not taking advantage of the potential of IS/IT for "transporting" them from an peripheral location to the centre of the markets. It can also be true that the stock of IS/IT capital of the Portuguese companies is not enough to produce positive impacts, they may be in the learning adjustment process. Also Portuguese managers could not be investing in complementary organizational investments to get better results from there IS/IT investments.

For the Portuguese case, we need to obtain more data for several years to build a lagged model, to observe the impact of IT expenditure on firm performance after a few years (learning adjustment).

In future work, we intent also to run separate regression for different sectors.

In the view of Crowston & Treacy (1986) we must look for a strong theory about the process in organizations to guide our choice of variables and to generate testable hypothesis about them.

Without a theory, we will be faced with far too many possible input or output variables and no way to control for the many interactions between them.

Simply empirical studies, without a strong theory-base, difficultly will reveal the heart of the IT pay-off question. Once we have chosen a reference discipline and thus our variables of interest, we can borrow accepted definitions and well tested methodologies to more systematic and valid studies.

Future research will be conducted using empirical data, and conclude if in firms with "stakeholder orientation" this relation is stronger, than with other companies. It is argued that the key in the positive impact of IS/IT on firm performance is the "stakeholder orientation" of the firm and its stakeholder management practices that motivates all stakeholder groups to act in order to create value.

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