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Article

The Impact of R&D Investment on the Performance of Portuguese Companies

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Abstract: The main objective of this study is to analyze the impact of investment in Research & Development on the performance and value of companies, that is, to try to explain how R&D investment influences the companies' performance. For this purpose, a dynamic panel data model was estimated using the Generalized Method of Moments, which made possible to measure the impact of R&D investment on performance through the Return on Operating Assets ratio for the Portuguese companies that invested the most between 2012 to 2019. The results show that the investment in R&D is not statistically significant in explaining the operating return on assets. However, the lagged financial performance in one period, the leverage, the asset turnover ratio and the accounts payable turnover show to have impact on the variable under study.

Keywords: intangible assets; investment; R&D; financial performance; generalized method of moments

1. Introduction

The high technological development that has been observed in major world economic powers has triggered in organizations a great interest in valuing themselves through the acquisition or internal generation of intangibles, thus obtaining a competitive advantage over their opponents, and some differentiation. In this context, the different business areas have had the challenging need for constant adaptation and updating, by developing rapid mechanisms that respond to the most diverse situations. Thus, Accounting, as a support base for Management, has also assumed a position of extreme importance insofar as these constant updates are reflected in the production of financial information.

Investment in R&D has proven to be a motivating aspect for companies as it brings benefits not only to the entity that carries it out, but also to society in general. However, the increase in R&D costs highlights the demand from managers for evidence of its impact on companies' performance. Some studies have already shown that investment in R&D made by companies positively affects their market value (see, for example, Chauvin & Hirschey, 1994; Bae & Noh, 2001). The literature reveals that investment in R&D has become a critical factor for the success and survival of companies, showing that it promotes competitive advantage through differentiation strategies that lead to the production of new and better products and services. It also identifies a problem in the production of financial information, regarding the valuation of R&D expenses arising from investment in intangible assets, and therefore, the present work addresses the deficiencies of the current accounting model as a general objective of analysis.

Knowing that there is no universally accepted model for valuing intangible assets resulting from research and development activities, and considering this condition as the motivation for this study, the specific objective of this work was to analyze the impact of R&D investment on the performance and value of companies.

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The research questions that this work intends to answer are:

1) How is the accounting treatment of intangibles and R&D expenses is carried out?

2) How does the investment in intangible assets resulting from R&D influences the companies' performance?

Given the relevance of the theme, the present work intends to be a contribution to the analysis of the impact of investment in R&D intangible assets in the Portuguese business environment.

After this brief introduction, the theoretical framework is presented highlighting the regulatory support applicable to R&D and the relationship between R&D and the companies' performance. The description of the methodology used to achieve the proposed objectives follows, and after that, the empirical study and the results obtained are presented, as well as their discussion. Finally, the main conclusions of the study are drawn up, as well as the limitations found and suggestions for future work.

2. Theoretical Framework

Firstly, the Portuguese regulatory framework regarding standards and fundamental concepts for the study will be made. Then, follows a reference to the problem of the current accounting difficulty in terms of intangible assets: the treatment of R&D expenses. The relationship between R&D investment and the companies' performance will also be analyzed and finally the evolution of investment in intangibles in the Portuguese businesses will be presented.

2.1. Applicable Regulations: Measurement, Recognition, and Disclosure

When Portugal joined the European Economic Community in 1986, it was necessary to adjust the existing regulations to the Fourth Directive (Directive nº 78/660/EEC). Thus, the Portuguese Official Chart of Accounts, which had proved to be out of step with reality, was subject to several successive changes resulting from the need to adapt the accounting model in force. This dynamic also emerged from the adoption by the European Union itself of International Accounting Standards, aiming at accounting harmonization as much as possible. Years later, with Decree-Law nº 158/2009 of July 13, the Accounting Standards System (ASS) came into force. ASS is very close to the new EU standards so that the country can achieve alignment with the European Union accounting directives and regulations. Within this modernization of the standards, it became possible to compare national companies and companies in international markets.

Regarding intangible assets, which are the focus of this work, they are accounted for by the Accounting Standard for Financial Reporting 6 – Intangible Assets (based on International Accounting Standard 38 – Intangible Assets). The Accounting Standard for Financial Reporting 6, §8 a), p.99 defines an intangible asset as "a non-monetary identifiable asset without physical substance", which determines some parameters that an asset must comply in order to be considered as an intangible asset and specifies how the carrying amount of this type of asset should be measured. This standard mentions three conditions for an asset to be defined as intangible, namely, identifiability, control, and future economic benefits. Regarding the criterion of identifiability, §12 states that an intangible asset is identifiable if it is separable from other items in the item category and can be sold, licensed, rented, or exchanged, or if it results from contractual or legal rights, regardless of whether these rights may be separable from the entity. As for control, it is explained in §13, p.99, which states that "an entity controls an asset if it has the power to obtain future economic benefits flowing to the entity, and can restrict the access of others to those benefits". Future economic benefits include revenues from the sale of products or services or other benefits arising from the use of the asset by the holding entity, as stated in §17.

At the level of the initial measurement of intangible assets, this should be done at cost (as indicated in §24), that is, the intangible asset should be carried at its cost less any amortization and accumulated impairment losses (§71). After initial recognition, §73 shows that the entity should adopt the revaluation model as a measurement metric, that is, the intangible asset should be carried at a revalued amount that is its fair value at the revaluation date, less losses subsequent accumulated impairment and less any subsequent accumulated amortization. In subsequent measurement, if the

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entity chooses to account for the intangible asset under the cost model, then all intangible assets in that class must follow the same assumption (§70). If, on the one hand, recognition is easy to interpret when the asset is purchased, on the other hand, when the intangible asset is generated internally, it is not. When the asset is acquired separately, §27 states that its cost is determined by its purchase price plus any cost that has been allocated to prepare the asset for its use. For internally generated assets, §64 states that the cost includes all costs directly attributed to creating, producing and preparing the asset to be able to work as intended. In the case of intangible assets generated internally, §49 recognizes the difficulty in assessing the recognition of the asset when situations such as 1) identifying whether and when there is an identifiable asset that generates future economic benefits and 2) determining the reliable cost of the asset. For assets with this particularity, it is important to clarify the concepts "research phase" and "development phase". Regarding the research phase, §52 clarifies that expenditures obtained in this phase should be recognized as an expense when they occur. Paragraph §53 adds that at the research stage the entity cannot demonstrate that an intangible asset that could generate future economic benefits exists. Regarding the development phase, §55 states that an intangible asset arising from this phase should be recognized only if the entity is able to demonstrate very particular conditions such as the feasibility of completion as well as the intention to complete the intangible asset so that it becomes available for use or sale; its ability to use or sell the intangible asset and to reliably measure expenditure on the intangible asset during the development phase; the way in which the intangible asset can generate future economic benefits and the availability of technical and financial resources to complete the development of the intangible asset. It should also be noted that §51 reinforces that if the entity cannot distinguish the research phase from the development phase of a project generated internally, then the entity should treat the expenditure as if it were incurred only in the research phase.

Dissemination of information about research and development activities has been considered an extremely important issue. Kang and Gray (2011) carried out a study to examine factors associated with the practices of dissemination of information about intangible assets of the 200 largest companies in emerging markets and concluded that the companies in the study voluntarily disclose the accounting information of their intangibles, however, this disclosure is affected by specific factors such as leverage, IFRS/US GAAP3 adoption, industry type and country-specific indicators such as economic policies and legal systems. It is therefore necessary to create conditions for the dissemination of information about intangible assets resulting from R&D activities (Bandeira, 2010a). This author analyzed the importance of R&D in the companies' valuation and the benefits of a correct valuation, translated into an increase in the quality of financial reporting. The study was based on a sample of the twenty companies that, worldwide, invested the most in R&D between 1996 and 2006, having concluded that there is a positive relationship between the results and, consequently, on the value of companies and their R&D activities (Bandeira, 2010b). In the same line of research, Polo and Vázquez (2016) carried out a study on the existing literature on the subject and disclosure of intangible assets and concluded that the relevance of this information is essential for stakeholders. According to Lev (1992) an adequate strategy of voluntary disclosure of credible information in a frequent and relevant way reduces the information gap between the company and the stakeholders. On the other hand, Nichita (2019, p. 225) analyzed research papers trying to answer the research question "How do researchers address the definition, measurement, recognition and potential of intangible assets to generate future economic benefits when a formal framework for reporting them is highly controversial?". In this study, research articles about intangible assets published between 2000 and 2019 were analyzed and it was concluded that research on intangibles does not have unanimous agreement regarding the definition, measurement, recognition and disclosure criteria, however, it recognizes the important contribution of these resources to boost the competitiveness, performance and gains of organizations. Alves and Pascoal (2017) argue that adequate measurement, recognition, and disclosure of information that reflects the company's economic situation makes accounting useful for decision making. Bandeira (2010b) proposes that the recognition of R&D expenses can be done through the allocation in full to results or through full or selective capitalization. Regarding the full allocation of expenses to results, considering the principle of

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prudence these are considered as expenses of the period in which they occur. This method can be reductive given that it can become difficult to apply, since when making a prediction of benefits it will not be possible to quantify them in the best way. Regarding full capitalization, it is based on the balancing principle, that is, the company incurs expenses to collect revenue in the future. This method incurs on the risk of recognizing fictitious assets, since a substance that does not have a realizable value is being accounted for as an asset. As for selective capitalization, it should treat R&D expenses according to the degree of certainty of future economic benefits.

2.2. Relationship between R&D and Companies' Performance

Compared to tangible assets, intangibles are associated with higher levels of uncertainty, as suggested by Gu and Wang (2005), since information about intangibles is more complex, see the example of technologies and patent property rights. In their study, Gu and Wang (2005) estimated the relationship between earnings forecasts made by analysts and the companies' intangible assets. The formalization of the hypothesis aimed to test: 1) whether the analysts' forecast errors regarding future earnings are higher for companies with a higher intangible purpose; 2) the existence of a positive association between the analysts' forecast errors and the diversity of the companies' technological investment portfolio; and 3) whether analysts' forecast errors are higher for companies with permanent investment in innovation. The results of this study showed the existence of a positive relationship between the analysts' forecast error and the intensity of intangibles that the company held. The same was true regarding the diversity and innovation of the companies' technology. Contrary to what Gu and Wang (2005) expected, the findings showed that industries with higher intensity of intangibles do not have higher forecast errors, and the regulation related to intangibles of biotechnology, pharmaceutical and medical equipment industries decrease the analysts' forecast error and their association with intangibles.

From the literature point of view, intangible assets represent an important part in determining the value of the company. In this line, Oliveira et al. (2010) tested the relevance of recognizing intangible assets and goodwill. These authors focused their study on the analysis of the financial reports of companies with values not listed on the Portuguese Stock Exchange between 1998 and 2008. After formulating hypotheses to test 1) the relevance of asset recognition on the market value of equity and 2) whether the relevance of the accounting value, gains and intangible assets recognized based on IAS differs from the information based on Portuguese accounting principles. The results showed that, with the change to IAS/IFRS, the increase in the relevance of intangible assets is very small, given the conservative nature of Portuguese regulations and the aforementioned international standards. Ely and Waymire (1999), Barth and Kasznik (1999) and Gelb and Siegel (2000) also developed research aiming to study if intangible assets associated with research and development and information asymmetry are significantly positive in relation to the publication of returns from repurchase shares. The conclusions obtained showed that companies with more intangible assets are more prone to share buybacks and to a lower information asymmetry towards investors. Ballester et al. (2003) showed that there are significant differences, since the time series assumes the invariance of the specific parameter of the company combined with time. The transversal approach on the other hand assumes that all companies have the same capitalization and amortization rates for their R&D expenses. As stated by Gelb and Siegel (2000), R&D and advertising expenses usually result in patents, technologies, and brand names that, because they are intangible, are difficult to valuate accurately. According to the same authors, an incorrect valuation leads to the creation of financial information that is not very useful and relevant for investors. Thus, they developed research with the purpose of understanding whether companies with significant levels of intangible assets are more likely to highlight the increase in dividends and share buybacks, which is usually seen as a way of recognizing favorable investment opportunities, rather than using ordinary accounting disclosures. Focusing on the theme of the economic value of R&D activities, Ballester et al. (2003) used past information on earnings, accounting values and R&D expenses to estimate the economic value of R&D that investors consider an asset. This study adapted the methodology used by Ohlson in 1995 to estimate the existence of unusual incomes, the proportion of current expenditure on R&D as a form

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of future economic benefit for the company and the amortization rate of that same asset. The authors compared the time series of data with the estimates of parameters of capitalization, persistence of earnings and the economic value of R&D intangibles and the cross-sectional series, and concluded that, in general, investors consider R&D expenditures as an economic good.

3. Methodology

The empirical study developed aimed to analyze the impact of investment in R&D intangible assets on the companies' value, with a special focus on Portuguese companies that invested the most in R&D in the period from 2012 to 2019.

3.1. Sample

The 25 portuguese companies that had the most investment in R&D in the period from 2012 to 2019 were selected for the sample resulting in a total of 200 observations.

After selecting the sample, data related to the variables identified in Table 1 were obtained and finally the *pml* package of R software was used to specify the panel data (R Core Team, 2021).

3.2. Variables

The variables used in the model were based on the study of Ayaydin and Karaaslan (2014) adapted to the reality of the Portuguese companies.

The dependent variable of the model is the financial performance of the company measured by the return on assets (ROA), which is calculated by the ratio between the operating result and the total assets, in the current period. This ratio is a measure of profitability and allows us to analyze the return generated by the company's total assets.

As in Lev et al. (2005), the return on assets was used as a measure of the company's profitability, since it is through it that the company's position is reflected. The company's performance was thus measured in terms of profitability and not in terms of innovative results (such as productivity or number of patents).

The independent variables used in the model are the firm size, liquidity, leverage, R&D investment intensity, operating efficiency ratios: turnover of receivables, payables, inventories and assets, and the level of technological intensity, coded by dummy variables. The firm size was measured by the natural logarithm of the total assets, to avoid any compound effect. The R&D investment intensity was calculated by the ratio between the investment in R&D and the total assets.

It became important to add lags of the dependent and independent variables since the analysis of economic and financial relationships usually observes economic behaviors that can be influenced by past experiences and old patterns.

Table 1. Description of the variables.

Variables	
Dependent variable	
Financial performance (ROA)	Operating result / Total assets
Independent variables	
Financial performance (ROA) (t-1)	Operating result (t-1) / Total assets (t-1)
Dimension	Log(Total assets)
Liquidity	Current assets / Current liabilities
Leverage	Liabilities / Shareholders' equity
R&D investment intensity	Investment in R&D / Total assets
R&D investment intensity (t-1)	Investment in R&D (t-1) / Total assets (t-1)
R&D investment intensity (t-2)	Investment in R&D (t-2) / Total Assets (t-2)
Asset turnover rate	Turnover / Total Assets

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Inventories turnover rate	COGS / Inventories
Turnover rate of accounts receivable	Turnover / Accounts receivable
Turnover rate of accounts payable	CGSMC / Accounts payable

Dummy variables

Technological intensity	High technological intensity Medium-high technological intensity Medium-low technological intensity Low technological intensity

Source: Adapted from Ayaydin and Karaaslan (2014).

3.3. Procedure

The formulation of the model that allows determining the impact of R&D on the firm's financial performance (ROA) is described in Equation 1 and includes: the financial performance lagged by one period, the firm size (DIM), the liquidity (LIQ), the leverage (LEV), the assets turnover rate (ATR), the inventories turnover rate (ITR), turnover rate of accounts receivable (TRAR), turnover rate of accounts payable (TRAP), R&D investment intensity (RD) and its lags of one and two periods, and the technological intensity of the firm (TI):

$$\begin{aligned} \mathrm{ROA}_{i,t} = {} & \beta_0 + \beta_1 \mathrm{ROA}_{i,t-1} + \beta_2 \mathrm{DIM}_{i,t} + \beta_3 \mathrm{LIQ}_{i,t} + \beta_4 \mathrm{LEV}_{i,t} + \mathrm{ATR}_{i,t}\beta_5 + \mathrm{ITR}_{i,t}\beta_6 + \\ & + \mathrm{TRAR}_{i,t}\beta_7 + \mathrm{TRAP}_{i,t}\beta_8 + \mathrm{RD}_{i,t}\beta_9 + \mathrm{RD}_{i,t-1}\beta_{10} + \mathrm{RD}_{i,t-2}\beta_{11} + \mathrm{TI}_{i,t}\beta_{12} + \varepsilon_{i,t} \end{aligned}$$

Note that index i represents the company and index t represents time. As mentioned, several explanatory variables are included also as lags.

Considering that some of the independent variables showed no statistical correlation with the dependent variable, five versions of this model were developed so that it was possible to measure their impact on the target variable.

4. Presentation and Discussion of Results

In a first phase, the results of descriptive statistics were obtained. They consist of measures that allow a description of the sample, namely by the value of the mean, median, maximum, minimum and standard deviation. Then, the five versions of the panel data model described by Equation 1 were estimated using the Generalized Method of Moments.

4.1. Descriptive Statistics

Table 2 presents the results of descriptive statistics (mean, median, maximum, minimum and standard deviation) for each dependent variable, obtained with a total of 200 observations.

Table 2. Descriptive statistics.

	Mean	Median	Maximum	Minimum	Standard-deviation	No. obs.
ROA	0.0659	0.0511	0.4939	-0.5389	0.1058	200
DIM	19.2649	18.8465	24.5094	16.7203	1.8202	200
LIQ	1.44	1.2138	6.8035	0.3629	1.1092	200
LEV	7.0858	1.5631	560.8876	0.1905	40.9572	200
RD	0.0556	0.0397	0.622	1e-04	0.0661	200
ATR	1.0591	0.86	4.436	0.1022	0.7226	200
ITR	7.1206	4.6212	104.302	0.46	9.8259	200
TRAR	12.8931	4.7818	168.2804	1.2494	25.6355	200
TRAP	3.6934	2.539	15.5081	0	3.0995	200

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The mean value of the return on assets shows that in the period from 2012 to 2019 the assets had the ability to generate an average positive operating result of 6.59%. The results in this table also show that the intensity of investment in R&D in relation to the asset, and considering average values, is 5.56%. Regrading to leverage, it represents the level of indebtedness used to maximize the return on investment. In this case, the average value is 7.09%, which shows that the companies under analysis have heavily resorted to debt to finance their assets. With respect to the effectiveness of the operational cycle, the turnover of assets is around 1.06, which means that, on average, companies are using their assets efficiently to generate sales. On the other hand, the average inventory turnover is 7.12, which means that, on average, stocks are renewed 7.12 times a year, that is, they remain in the companies for about 1 month and 21 days. The average turnover of accounts receivable is 12.89 days and the average turnover of accounts payable is 3.69.

Regarding technological intensity, as shown in Table 3, the sample is composed of 8 companies with a high level of technological intensity (32%), 9 companies with a medium-high level of technological intensity (36%), 1 company with medium-low level of technological intensity (4%) and 7 companies with low level of technological intensity (28%).

Table 3. Distribution of the sample's technological intensity.

	Nº	%
High technological intensity	8	32%
Medium-high technological intensity	9	36%
Medium-low technological intensity	1	4%
Low technological intensity	7	28%
Total	25	100%

Table 4 presents the Pearson's correlation matrix for the dependent variables. Pearson's correlation assumes values in the interval [-1;+1] and measures the magnitude and direction of the linear association between two variables, with -1 meaning the existence of a perfect negative linear relationship (when one variable increases the other variable decreases), and +1 meaning the existence of a perfect positive linear relationship (when one variable increases the other variable also increases).

Table 4. Pearson's correlation matrix.

	ROA	DIM	LIQ	LEV	RD	ATR	ITR	TRAR	TRAP
ROA	1								
DIM	-0.1485*	1							
LIQ	0.1054	-0.1249•	1						
LEV	-0.1633*	0.1371•	-0.0403	1					
RD	**0.103**	-0.4527***	-0.0075	-0.0980	1				
ATR	**0.3049*** **	-0.3862***	-0.0718	0.0082	0.2373***	1			
ITR	0.0178	**0.3127*** **	-0.1540*	-0.0527	0.0582	0.0369	1		
TRAR	-0.0476	**0.736*** **	-0.1719*	-0.0118	-0.2471***	-0.2423***	**0.5085*** **	1	
TRAP	**0.4078*** **	-0.0209	0.4168***	-0.0894	0.1347•	**0.4754*** **	0.2553***	0.1670*	1

Note: •, *, ** and *** correspond to the statistical significance levels of 10%, 5%, 1%, and 0.1%, respectively.

It is commonly assumed that correlation values between 0 and 0.3 indicate the existence of a weak positive relationship and values between -0.3 and 0 indicate the existence of a weak negative relationship. Values between 0.3 and 0.7 / -0.3 and -0.7 indicate that the relationship is moderate positive/negative. For the range 0.7 to 1 / -0.7 to -1 the relationship is assumed to be strong

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positive/negative. As can be seen in Table 4, there is a moderate positive correlation between the financial performance (ROA) and the assets turnover (ATR) and also with the accounts payable turnover (TRAP) (about 0.30 and 0.41, respectively). There is also a moderate positive correlation between the inventory rotation (ITR) and dimension (DIM) (about 0.31). There is also a moderate positive correlation between the turnover of accounts payable (TRAP) and the turnover of assets (ATR) (around 0.48). The turnover of accounts receivable (TRAR) also shows a moderate correlation with the turnover of inventories (ITR), in the order of 0.51. The turnover of accounts receivable (TRAR) shows a strong correlation with the dimension (DIM), of approximately 0.74. As expected, there is a positive, albeit weak, correlation between the performance (ROA) and the investment in R&D (ID) of around 0.10, although not statistically significant (the null hypothesis that the correlation is zero is accepted, since the p-value is greater than 0.1).

It was found that the variables LIQ, RD, ITR and TRAR show a correlation with the performance (ROA) that is not statistically significant, so five additional models were also considered by introducing them individually and incrementally, in order to test their impact on the dependent variable.

As already mentioned, if the correlation between two variables is negative, this means that they are negatively correlated, that is, when one variable increases its value, the other decreases, as is the case of DIM variable and ROA variable whose correlation (of around -0.15) is statistically significant at least at the 5% level, albeit in opposite directions.

4.2. Estimation

Table 5 shows the results of the robust GMM estimation of the dynamic panel data models considering six variations (of the model in Equation 1) according to the Pearson's correlation matrix. The variable of intensity of investment in R&D on the current period and its two lags, the variable ITR, the variable TRAR and the variable LIQ were introduced individually.

The results in Table 5 show that leverage has a negative effect on ROA, as in the study by Ayaydin and Karaaslan (2014), demonstrating that companies prefer internal funds when making capital structure decisions. When ITR and TRAR variables are both introduced, the LEV variable is no longer statistically significant.

Table 5. Robust GMM estimates of the dynamic panel data models.

Explanatory variables	**Dependent variable: ROA**					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Lag(ROA, 1)	0.194	0.207	0.250	0.477**	0.513**	0.471**
	(0.191)	(0.181)	(0.178)	(0.234)	(0.254)	(0.220)
DIM	0.001	0.001	0.001	0.001	0.0003	-0.011
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.009)
LIQ		0.004	0.002	0.003	0.004	0.004
		(0.008)	(0.009)	(0.009)	(0.010)	(0.013)
LEV	-0.0003*	-0.0004**	-0.0004**	-0.0002	-0.0002	-0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.002)	(0.0002)	(0.0001)
Lag(RD, 0:2)0			-0.136	0.023	0.116	0.156
			(0.169)	(0.284)	(0.333)	(0.309)
Lag(RD, 0:2)1			0.071	0.103	0.028	-0.026
			(0.181)	(0.294)	(0.224)	(0.206)
Lag(RD, 0:2)2			-0.001	-0.110	-0.099	-0.191
			(0.112)	(0.215)	(0.221)	(0.215)
ATR	0.016*	0.016*	0.015*	0.008	0.011	0.006
	(0.009)	(0.009)	(0.009)	(0.013)	(0.014)	(0.022)
ITR				-0.0004	-0.0005	-0.0003
				(0.001)	(0.001)	(0.0004)
TRAR	0.006**	0.005**	0.006**	0.003	0.0002	0.002
	(0.003)	(0.003)	(0.003)	(0.005)	(0.006)	(0.005)
TRAP					0.0002	0.001*

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					(0.0004)	(0.0003)
IT1						0.236 (0.176)
IT2						0.228 (0.181)
IT3						0.259 (0.165)
IT4						0.217 (0.191)
No. of obs.	200	200	200	200	200	200

Note: *, ** and *** correspond to the statistical significance levels of 5%, 1% and 0.1%, and the value in parentheses is the standard error.

In terms of operational effectiveness, the ATR and TRAP variables are statistically significant to explain operational profitability (ROA) at least at the 5% level, when TRAR and ITR variables are not included. On the other hand, inventory rotation (ITR) has a negative impact on profitability, which contradicts the results obtained by Ayaydin and Karaaslan (2014).

However, as previously mentioned, inventory turnover has a ratio of 7.12. On the one hand, this ratio is a reasonable value, but on the other hand, the estimation data shows a negative impact on the companies' performance, which is unusual since the higher this ratio is, more is produced or sold, and therefore the impact on profitability should be positive.

Regarding previous year's profitability (Lag(ROA, 1)), it is statistically significance at least at the 1% level, thus demonstrating a positive impact on current year profitability for models 4, 5 and 6.

The size variable (DIM) has a negative impact on firm's performance in model 6 with the inclusion of all variables under study. This result was not expected since the sample mostly considered big companies which normally have advantages in terms of investment in R&D (compared with smaller companies), and it is possible to increase the degree of innovation.

Concerning technological intensity, it proved to have a positive impact on companies' performance, showing that profitability is influenced by the level of technological intensity.

The results in Table 5 also show that investment in R&D is not statistically significant, with the lags for the previous two years having a negative impact on the performance of the companies under study. This occurs because investment in R&D implies an initial cost and consequently an associated risk and, therefore, only after overcoming this initial risk it will be possible to observe the positive return on investment. Additionally, and from a more commercial perspective, it is also necessary that innovative products resulting from this investment to be accepted in the market so that this initial recovery is possible.

In conclusion, it is possible to state that until this acceptance, investment in R&D will be nothing more than a cost borne for companies, and therefore the negative impact of this variable on companies' performance may be related to the recognition of this cost.

5. Final Remarks

R&D has been gaining importance in the Portuguese business world and the main objective of this work was to analyze the impact of this investment on the performance of Portuguese companies.

Regarding the accounting treatment of R&D expenses, the state-of-the-art indicates that there is still no conceptual framework for the treatment of this type of item in order to make it as realistic as possible in terms of value for the company and consequently for its stakeholders.

In fact, the results obtained were somewhat unexpected since the intention was to demonstrate that for this type of companies, the return on assets is partly explained by the investment in R&D, and that there is a relationship between these two variables.

However, the results obtained show that most of the variables are not statistically significant to explain the corporate's performance. It is possible to conclude that R&D investment does not explain the evolution of the corporate's performance, at least in the short term, that is, this investment, which is initially seen as a cost, may only later prove to be a contributing factor to financial performance.

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In general, the variables that may contribute (even some of them minimally) to the financial performance are the financial performance one-period lagged, the leverage, the assets turnover rate and the turnover rate of accounts payable.

Finally, it should be mentioned that the contribution of R&D investment to return on assets was not fully perceptible in this study, but it can be with the analysis of other types of parameters, such as the number of patents for example. The main limitation of this study was the lack of data since not all companies in the sample provided information for all years and for all variables, making the study difficult to carry out and somehow limited the robustness of the results obtained.

We suggest applying the model studied for the post Covid-19 pandemic years, so that it can be possible to recognize its impacts on the investment of intangible assets in the various sectors, and more precisely in the Portuguese business environment.

On the other hand, for future research, we suggest that the impact of investment in R&D on the companies' performance could be assessed considering the number of patents or the number of innovative products that companies have been developing, since it was clear the existence of little relationship between investment in R&D and the improvement of the financial performance of the companies under study.

References

Afonso, O., & Bandeira, A. (December de 2010a). Value of intangibles arising from R&D activities. *The Open Business Journal, 3*, 30-43. Obtido de http://www.bentham.org/open/tobj/articles/V003/30TOBJ.PDF

Alves, M., & Pascoal, M. (2017). Mensuração e reconhecimento contabilístico dos ativos biológicos: um estudo de caso. *Revista Contemporânea de Contabilidade*, 46-66.

Ayaydin, H., & Karaaslan, İ. (2014). The Effect of Research and Development Investment on Firm's Financial Performance: Evidence from Manufacturing Firms in Turkey. *The Journal of Knowledge Economy & Knowledge Management (Bilgi Ekonomisi ve Yönetimi Dergisi), 9*, 23-39.

Ballester , M., Garcia-Ayuso, M., & Livnat, J. (2003). The economic value of the R&D intangible asset. *European Accounting Review, 12*(4), 605-633.

Bandeira, A. M. (2010b). *Intangible Assets and R&D Activities (in portuguese).* Porto: Vida Económica.

Barth , M., & Kasznik, R. (1999). Share repurchases and intangible assets. *Journal of Accounting and Economics, 28*(2), 211-241.

Castilla-Polo, F., & Gallardo-Vázquez, D. (2016). The main topics of research on disclosures of intangible assets: a critical review. *Accounting, Auditing & Accountability Journal, 29*(2), 323-356.

Chauvin, K. W., & Hirschey, M. (1994). Goodwill, profitability, and the market value of the firm. *Journal of Accounting and Public Policy, 13*(2), 159-180.

Decreto-Lei n.º 158/2009, de 13 de Julho. *Diário da República n.º 133/2009 - I Série*. Lisboa: Ministério das Finanças e da Administração Pública

Ely, K., & Waymire, G. (1999). Intangible Assets and Stock Prices in the Pre-SEC Era. *Journal of Accounting Research, 37*, 17-44.

Gelb , D., & Siegel , P. (2000). Intangible Assets and Corporate Signaling. *Review of Quantitative Finance and Accounting, 15*, 307-323.

Gu, F., & Wang, W. (2005). Intangible Assets, Information Complexity, and Analysts Earnings Forecasts. *Journal of Business Finance & Accounting, 32*(9-10), 1673-1702.

Kang, H. H., & Gray, S. J. (2011). Reporting Intangible Assets: Voluntary Disclosure Practices of Top Emerging Market Companies. *The International Journal of Accounting, 46*(4), 402-423.

Lev, B. (1992). Information Disclosure Strategy. *California Management Review, 34*(4), 9-32.

Lev, B., Sarath, B., & Sougiannis, T. (2005). R&D Reporting Biases and Their Consequences. *Contemponary Accounting Research, 22*(4), 977-1026.

Nichita, E.-M. (2019). Intangible assets – insights from a literature review. *Accounting and Management Information Systems, 18*(2), 224-261.

Rodrigues, L., Craig, R., & Oliveira, L. (2010). Intangible assets and value relevance: Evidence from the Portuguese stock exchange. *The British Accounting Review, 42*(4), 241-252.

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