INTERNATIONAL JOURNAL OF BUSINESS, 10(3), 2005 ISSN: 1083-4346

R&D Investment and the Financial Performance of Technological Firms

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ABSTRACT

The growth of technological firms is based on the exploitation of innovative products and services thus forcing them to strongly invest in research and development (R&D). If the R&D expenditures announce the strategic positioning of firms, they can also significantly decrease the financial performances in terms of net income, return and risk.

With the IAS 38 standard, the R&D expenditures can be accounted as expenses or assets. This choice has an impact on financial performances but this effect is difficult to forecast because these expenditures increase the information asymmetry between shareholders and managers. We demonstrate that it is preferable to capitalize the R&D expenditures if the firm is able to draw an immediate commercial exploitation from them or to adopt a swarming strategy of innovative projects (spin-off) as the benefits arise in the future.

JEL: G32, G14, L19, O33

Keywords: R&D; Intangible asset; Capitalization; Value; Beta; Return; Performance; Risk; Accounting standard; IAS 38; Swarming; Spin-off

[*] The authors would like to acknowledge the Fonds Social Européen for its financial support.

I. INTRODUCTION

The nature of investments realised by firms have especially changed during the last twenty years; intangible investments developed quickly and represent a large proportion of the firms assets, which by nature are difficult to evaluate. The research and development (noted R&D thereafter) expenditures are strategic and sensitive because they intervene in the upstream of the production cycle and reveal the strategic orientations of firms. The decisional choices, resulting from the process of knowledge acquisition and rights, are irreversible and structure firms, sometimes putting them in danger. Moreover, the control of R&D activities is delicate because the developing complexity of technological projects generates an increase of control costs to overcome the information asymmetry. This is the reason why we questioned the incidence of the integration strategies upon the financial performance of firms. This research lies within the scope of the implementation of IAS 38 standard[1] in the European Union for firms listed on stock exchanges. This standard should help the financial communication on intangibles assets.

Previous research shows that firms which undertake intense R&D expenditures reinforce their position on the market by improving their sales. Nevertheless, these studies did not lead to a consensus about the impacts on income and financial performance. This last aspect remains under researched.

This paper is organized in two parts. In Section II, we located our research in R&D literature in order to define our framework. We formulate assumptions to study the impacts of R&D expenditures on income, financial performance and risk of firms. In Section III, after a descriptive analysis of our sample, we test our assumptions using simple and multiple regressions, as well as tests of differences of the averages. Lastly, we discuss the results obtained in order to show what can be of interest for technological firms to adopt a strategy of R&D expenditures capitalization.

II. THEORETICAL FRAMEWORK

Among the studies on the performance, value and risk of the intangible assets, R&D occupies a dominating position because of the link of this intangible element with the theories of the innovation in economy. In this section, we present a review of the literature about the impacts of R&D expenditures on the firm's value, its performance and its risk in order to elaborate our assumptions.

A. R&D and the Firm's Value

Many researchers have been interested in the relationship between R&D expenditures and the firm's value. These studies are founded on a stock exchange analysis of the firms that realized immaterial capital expenditures. The objective is to establish a link between the evolutions of the market value of firms and their immaterial expenditures, generally limited to the expenditures of R&D, publicity, and patents. This market value is expressed as the sum of the market value of the tangible and intangible assets. To

explain the link between "R&D and the firms value ", the review of the literature suggests to use the “Q of Tobin” indicator expressed by the ratio:

$$Q_t = MV_t / RC(T_t + I_t) \quad (1)$$

where MV_t is market value of the assets and $RC(T_t + I_t)$ is replacement value of the tangible assets (T_t) and intangible assets (I_t).

According to its creator, this ratio must equal one. However, the review of the literature studied thereafter, shows that generally this is not the case, which allows for many interpretations. For Tobin (1978) this indicates an imbalance, and thus profitable investment or disinvestment opportunities. Whereas for Salinger (1978), Bulow (1985), and Wernerfelt and Montgomery (1988), this imbalance is due to the off-balance sheet elements (like the provisions for retirements), or to strategic factors (monopoly rent, diversification). The latter authors postulate that the “Q of Tobin” variable consists of measuring the difference between the current value of a firm (market value, output) and the initial value of the resources used to create the firm (historical book value, input). This ratio is thus a measurement of the firms performance since its creation and has to be higher than 1.

Other authors such as Griliches (1981), Cockburn and Griliches (1988), Hall (1988), Megna and Klock (1993), Chung and Pruitt (1996) considered this ratio Q as an indicator of the intangible assets of a firm not recognized in accounting.

Today, this approach is generally adopted and numerous studies shown a strong correlation between this Q ratio and the intangible expenditures of firms, in particular the R&D expenditures (Hirshey and Weygandt 1985; Skinner 1993; Agrawal and Knoeber 1996).

The results obtained seem to be unambiguous; R&D expenditures positively and significantly correlate with the market value of firms. These expenditures are valued by the market as assets which will generate additional cash-flows in the long term. For example, Pakes (1978, 1985) found that an increase in R&D expenditures or patents has a positive and significant impact on the firm’s value.

Another approach, founded on heuristic models, comes to confirm this correlation between R&D expenditures, net income and the firm’s value. Connolly and Hirschey’s (1984) study, which concentrated on 390 firms of the classification Fortune 500, showed the existence of a positive correlation between the R&D expenditures and the firm’s value. This tends to validate the concept of intangible capital.

Nakamura and Leonard (2001) added that during the last decade, studies regularly highlight that the R&D expenditures of a firm increase its market value of an amount at least equivalent to these expenditures. However Lev (1996) does not recognize the stock exchange as a means of evaluating intangible assets. Using the results recorded by Chan, Lakonishok and Sougiannis’s (2001) study, it can be seen that the market systematically underestimates the firm’s value realizing significant intangible investments, in particular in R&D.

Thus, these studies show that there is a positive correlation between the R&D expenditures and the firm’s value quoted on stock exchange. The current value of the Q of Tobin rate can be explained by the fact that firms are moving to adapt to a certain

economic reality where the intangible elements play a crucial role for their development. This importance of the intangible elements is appreciated through its impact on the firm's performance in the following section.

B. R&D and the Firm's Performance

Beyond their impact on the firm's market value, R&D expenditures have an influence on the firm's performance, which is appreciated in terms of income and return.

1. Impact on income

On this point, we can note in particular the contribution of Sougiannis (1994), who studied the correlation between the annual R&D expenditures and the net income announced by the firms in their annual report. Its two main results are (a) a dollar spent in R&D induces an average net income rise of 2 dollars over the following 7 years, which means a return of these investments of 26% per year on average, and (b) a dollar spent in R&D leads to a rise of almost 3 dollars of the firm studied value. But Morbey (1989) affirmed that there is any link between the R&D expenditures of American companies and the growth of their profit.

In Europe, because of the IAS 38 standard, the result of this type of study depends on the way in which these expenditures are accounted whether as expenses or assets. Ding and Stolowy (2003) worked on the reasons for which French firms capitalize their R&D expenditures and the relevance of this strategy. Their analysis did not provide any result to show this. They just identified, for the French domestic market, the firm's characteristics (high tech industry and having a high risk beta) that can predict their R&D capitalization.

Other authors studied this type of relationship by looking at other factors, like the sales growth, instead of the net income. So, Brenner and Rushton (1989) noticed that the firms which have higher R&D expenditures on average obtain a sales growth rate higher than the market average rate, and vise versa.

2. Impact on return

We have indexed three studies that would confirm the assumption of a positive incidence of R&D expenditures on the return of firms. Chan et al. (1990) highlighted a positive reaction of the firm's stock exchange prices when they announce the increase of their R&D expenditures. Canibano, Garcia-Ayuso and Sanchez (2000) asserted that return rises with the increase of the R&D expenditures. It is by supposing that the investments in R&D help to increase future profit, that this sort of research identifies this positive and significant link.

However, Sundaram, John and John (1996) reached the opposite conclusion. They did not find a positive relationship between R&D expenditures and stock exchange prices. By refining their study, they showed that the reaction of the market depends on the level of competition in the sector; an increase of R&D expenditures in a non-competitive sector (weak competition) leads to a rise of the initiating firm's stock

price. On the other hand, in a very competitive sector, this type of announcement induces a fall of the firm's stock price. This difference, concerning the impact on the stock price, is noted by other authors like Hall (1993) and can be explained by the fact that the results depend on the period of the study, and in particular, if they were carried out before or after the year 1985, which seems to be a hinge year in terms of investor behaviour in the United States.

These various studies assert that the R&D expenditures of a firm influence its value, return and its accounting figures with, however, a strong sensitivity to the economic situation and the competition in their sector. Consequently, we make the following assumption:

H1.1: The return of technological firms is decreasing with the intensity of the expenses in R&D (expenses of R&D/turnover).

On the other hand, a firm which intensely exploits the results of its research should generate a significant turnover compared to its intangible assets and have weak intangible fixed assets compared to its total assets. Indeed, if the R&D expenditures are accounted as expenses, they strongly decrease the firm's income but if they are capitalized, they weigh down the balance sheet. In the first case, they deteriorate the margin ratio and in the second case, they decrease the financial lever, finding its origin in asset rotation. So, we can deduct the following assumptions:

H1.2: The firm's return increases when the R&D expenditures are accounted as expenses rather than assets.
H1.3: The firm's return grows when its EBIT is significant compared to its intangible assets.

C. Expenditure of R&D and Risk of the Firm

The immaterial elements put the firm in a situation of informational asymmetry compared to the market because it obviously lacks control on the contents as well as on the prospects for future profit. The immaterial investments require an attentive management and specific means because of their particular risks. Indeed, the future value of these assets is not guaranteed. These R&D projects imply very high development and control costs. From this point of view, firms must exert high expenditures for a dubious future return.

More over, innovating firms generally have a strong growth. This induces a risk of growth that can lead to problems of liquidity, and bankruptcy especially because these firms are generally small and do not have the financial strength necessary to absorb these crises. In the technological sector, like the pharmaceutical industry, many research projects are developed by small specialized laboratories that, in the event of success, sell or lay off their discoveries to big groups. This is because the uncertainty of the innovations created involves a technological and competitive risk - the first is that a technological rupture brutally makes obsolete the discovery, the second is that its discovery will not become a market standard - which small firms cannot assume.

In a study on the failure factors of investment projects, Mansfield and Wagner (1975) showed that intangible investments have a greater probability of failure than tangible investments. For Williamson (1988), the absence of materiality in these investments, associated with the absence of secondary market, implies that there is not real guarantee put on the asset, and this leads to a stronger risk of insolvency.

Studies realized by Mansfield and Wagner (1977), Griliches (1979), Jaffe (1986), Audretsch and Feldman (1996) demonstrate that the spillovers relating to processes of specific R&D make it possible for competitors to gain competitiveness at a lower cost; the imitation of the processes. These studies show in particular that, in the sectors with a strong intensity of R&D, the R&D expenditures increase the competitor's inventories of knowledge and improve the results of their research.

Another characteristic intangible expenditure is irreversibility, i.e. if a firm stop a project, it cannot recover all the money invested, because generally these investments are partly specific to the firm and cannot be sold at their acquisition cost.

Lastly, with regards to the link between risk of the firm and R&D expenditure, Ding and Stolowy (2003), in a study on the capitalization of R&D expenditures applied to a sample of 68 French firms belonging to the SBF 250 index, noticed that the companies which capitalize their R&D expenditures have a high beta risk. The study of Ho, Zhenyu, and Yap (2004) leads to the same conclusion. Based on a broad sample of American firms characterized by a very significant stock exchange capitalization, this study indicates a very great return for firms with very intensive R&D expenditures. At the same time, the analysis of the correlation confirms that the intensity of the R&D expenditures positively relates to the systematic risk of the stock market. Thus, we can elaborate the following assumptions:

H2.1: the more intense the R&D expenses of a firm are, the riskier the firm is (high beta).
H2.2: The risk of the firm is higher when it capitalizes its R&D expenditures.
H2.3: The firm is less risky when its EBIT is high compared to its intangible fixed assets.

The review of the literature insists on contradictory results about the incidence of the R&D expenditures on the firm's financial performance. Our synthesis and observation led us to suppose that if the R&D expenditures should indicate the capacity of a firm to maintain its competitive advantages. Firstly there are sources of expenses coming to decrease the firm's return. Moreover, the asymmetry of information being increasing with the R&D expenditures, they would enhance the perceived risk by the investors.
In order to test these assumptions, we chose to focus our study on technological firms because their activities are based on the economic exploitation of their R&D results. In the following section, we expose the characteristics of our sample and the methodology employed to test these six assumptions.

III. EMPIRICAL RESULTS

A. Sample and Methodology

For the purpose of our analysis we use data from the 2004 annual report of firms and the JCF Quant software. For homogeneity, the firms of our sample are exclusively listed on EURONEXT and NASDAQ. Our sample is composed of 213 firms in technological sector[2].

The annual return of a share is obtained by summing the daily returns that are calculated with the closing prices. For each firm of the sample, the beta is the covariance of the daily stock return with the daily market index return divide by the variance of the daily market return.

The objective of the regression analysis, which we lead in the empirical part, is to explain the firms financial performance in the sample, in terms of return and beta, (the metric dependent variables) with the other accounting metric independent variables.

B. Descriptive Analysis of the Sample

The technological firms of our sample have R&D expenditures accounted as expenses in the income statement, which rise on average to 100,7 million euros. These expenses are highest for the aerospace and telecommunications sectors, with respectively 312 million euros and 55,3 million euros. For the software sector, expenses in R&D are on average 33,7 million euros and 1,47 million in biotechnologies sector. More over, the companies in the aerospace and telecommunications sectors have the largest total assets and the he biotech firms are the smallest: the size is nearly 94 times lower than those in the aerospace sector. These statistics show that biotech firms are mostly spin-off of pharmaceutical groups or large laboratories.

The averages EBIT and intangibles assets also follow the same order. However, this order is reversed when we look at intangible assets with regards to the total assets (the intangibility of the firm). Whereas the firms in the biotechnology and the software sectors have respectively 6,8% and 5,6% (medians) intangibles to their total assets, firms in the telecommunications and aerospace sectors have close to two times less intangible assets (respectively 3,7% and 3,9%). These observations point out that these last two sectors invested and capitalized less in R&D expenditures.

We approximate the R&D capitalization intensity with the ratio: intangible asset / R&D expenses, that we call the R&D capitalization ratio. For firms with significant R&D expenditures, a high R&D capitalization ratio means that the firm strongly account their R&D expenditures as intangible assets. Intangible assets are then high compared to the R&D expenses. We will see later that the R&D capitalization ratio must be combined with the R&D expenses ratio to improve financial analysis. But before going further in the interpretation of the descriptive statistics, let us recall that the ratio of R&D expenses is high if the expenditures in R&D, registered in the income statement, are high compared to the EBIT.

The median of the R&D capitalization ratio for our sample of technological firms is 1,446. The expenses in R&D thus represent about two-thirds the intangible assets. The median of this ratio appears particularly low in biotechnology firms (0,66). One explanation of this observation is that investments in R&D are capitalized in the balance sheet. If, one observes a low R&D expenses ratio, one can then conclude that the firm does not have a strategy to indicate the quality of its projects by displaying only its expenditure in R&D. This can be shown in the biotechnologies sector since the median of the R&D expenses ratio is low (0,7). One explanation is that the R&D expenses have a large proportion of the operating costs and that it is preferable to reveal this expenditure by increasing the EBIT. On the other hand, expenses in R&D in the software industry represent 1,26 times the EBIT. Indeed, in a lot of cases, the net income is inevitably negative. In addition we can observe an R&D capitalization ratio of 1,82, nearly three times superior to the biotechnology sector. In this sector, it seems that companies tend to announce the quality of their projects by showing explicitly their investments in R&D.

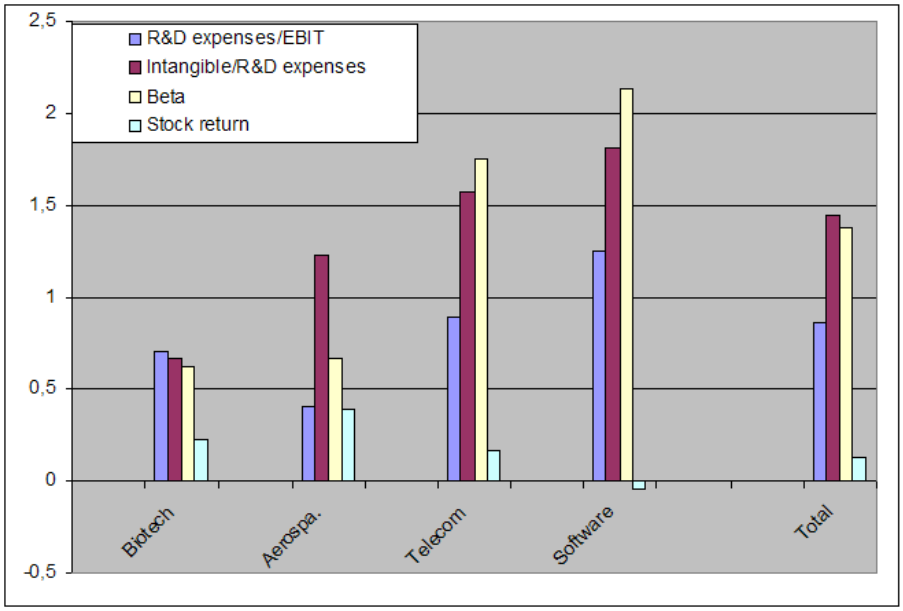
Table 1
Indicators of accounting integration of the R&D expenditures

Sector	Statistics	R &D expenses /EBIT	Intangibles / asset	Intangibles / R&D expens.	Intangibles / EBIT
Aerospa.	Average	1.1292	0.0694	2.4330	1.8506
	Median	.4035	0.0391	1.2278	.7091
Biotech	Average	1.0138	0.1229	2.1139	2.6895
	Median	.7000	0.0681	.6634	.4989
Software	Average	2.6260	0.0647	3.1118	6.9787
	Median	1.2568	0.0566	1.8209	2.4276
Tele COM	Average	1.5683	0.0613	4.8426	4.6729
	Median	.8881	0.0372	1.5735	1.5501
Total	Average	1.8709	0.0707	3.2636	4.8209
	Median	.8671	0.0443	1.4465	1.2612

Graph 1 helps us to visualize that the median of the R&D capitalization ratio is close to the R&D expenses ratio for the four sectors. Indeed, it seems that the capitalization of the R&D expenditures are related to the economic cycle. In the software sector, the entry barriers rely essentially on intense short-term technological renewal. This is because, on the one hand, the software remains difficult to patent (although it is made possible in the United States) and on the other hand, the cycles of innovation are very short (for example six months for the videogames and up to 3 years for professional software). The investments of R&D are appropriate in the short term. In general in biotechnologies, the economic cycles are more than ten years. Commercial exploitation

often takes place in a situation of monopoly because of the patents and commercial licences. These are genuine entry barriers for the competitors in this sector. The investments in R&D are appropriate for a long-term strategy and mostly appear in the operating costs, because they are part of the economic cycle.

Graph 1
Intensity of R&D expenses and capitalization



NB: the figures come from the sectorial medians calculated in the previous table

The graph above points out that the aerospace and biotechnologies sectors are a less likely to account their R&D expenditures as expenses, compared with the telecom and software sectors. The following table shows, the median of the betas in the aerospace and biotechnology sectors are 0,65 and 0,61. Thus, it testifies that those industries are not very risky compared to the telecom and software sectors, which respectively have betas of 1,76 and 2,13.

These sectors can be grouped in two categories: (1) sectors with strong signal of investment in R&D (telecommunications and software), and (2) sectors with low signal of investment in R&D (biotechnologies and aerospace).

We observe on our sample of technological firms that the median return is 13,5 % for a median beta of 1,33. The median beta is three times superior for the sectors with a strong activity in R&D since it is 1,95 against 0,63 (median) for the firms with

low ratios. Cumulated returns follow a reversed order because the sectors integrating their expenditures in R&D have returns nearly 9 times lower: 4% against 34%.

Table 2
Integration of the R&D expenditures and firms financial performance

Signal	Sector		Beta	Return
Sectors with low signal in R&D – 0	Aerospac	Average	.6400	0.6106
		Median	.6500	0.4
	Biotech	Average	.5357	1.0043
		Median	.6100	0.24
	Total	Average	.6092	0.727
		Median	.6300	0.34
Sectors with low signal in R&D – 1	Software	Average	2.1686	0.0769
		Median	2.13	-.0400
	Telecom	Average	1.757	0.3288
		Median	1.76	0.175
	Total	Average	2.0247	0.165
		Median	1.95	0.04

These first statistics highlight that the firms in the telecommunications and software sectors are underperformers in term of return and beta, compared to the firms in the aerospace and biotechnologies sectors. We continue our analysis using simple and multiple regressions to examine whether the accounting strategies of investments in R&D have an effect on the financial performances of the technological firms, or if we are more simply facing sectorial effects.

C. Accounting of R&D Expenditures and Financial Performance

1. The correlations matrix

The existence of negative returns and betas led us to a shift of the scale. After, we have proceeded to a logarithmic transformation for each variable and drew up the matrix of correlations. We examine the effect of our variables on the financial return by analyzing the results of the simple and multiple regressions. Finally, while following the same process, we studied the effect of our variables on the financial risk beta. This methodology allows us to confirm the assumptions we posed in our review of the literature, and to examine whether there are differences in the average of the financial performances according to the selected strategies.

The following sections discuss the correlations between the studied variables and the financial performances of the firm, and between the variables themselves.

Table 3
Pearson correlations matrix

		RD expens./ EBIT	Intangible/ RD expenses	Assets/ RD expens.	Intangib /EBIT	Intangib /asset	Beta	Return
RD expens. /EBIT	Correlation of Pearson	1	-.173*	-.447**	.572**	.139*	.331**	-.167*
	Sig. (bilateral)	.	.012	.000	.000	.043	.000	.015
Intangible/ RD expens.	Correlation of Pearson	-.173*	1	.557**	.709**	.765**	.054	-.138*
	Sig. (bilateral)	.012	.	.000	.000	.000	.431	.046
Assets/RD expens.	Correlation of Pearson	-.447**	.557**	1	.145*	-.109	.211**	-.188**
	Sig. (bilateral)	.000	.000	.	.035	.114	.002	.006
Intangib. /EBIT	Correlation of Pearson	.572**	.709**	.145*	1	.738**	.286**	-.234**
	Sig. (bilateral)	.000	.000	.035	.	.000	.000	.001
Intangib /asset	Correlation of Pearson	.139*	.765**	-.109	.738**	1	-.094	-.022
	Sig. (bilateral)	.043	.000	.114	.000	.	.171	.754
Beta	Correlation of Pearson	.331**	.054	.211**	.286**	-.094	1	-.200**
	Sig. (bilateral)	.000	.431	.002	.000	.171	.	.003
Return	Correlation of Pearson	-.167*	-.138*	-.188**	-.234**	-.022	-.20**	1
	Sig. (bilateral)	.015	.046	.006	.001	.754	.003	.

* The correlation is significant at level 0.05 (bilateral) ** the correlation is significant at level 0.01 (bilateral)
Incorpo./EBIT: intangible fixed assets/turnover

2. R&D investment and the return of technological firms

The table of correlations reveals that the intangibility of the firm, measured by the intangible assets to the total assets, does not have any relationship with the stock returns of technological firms (correlation = -0.022). On the other hand, we can observe a weak negative correlation (-0.167*) of the stock returns with the R&D expenses ratio (R&D expenses/EBIT) and a weak negative correlation of -0,138* with the R&D capitalization ratio (Intangible assets/R&D expenses). Although these results are significant only with an error threshold of 5%, they are useful to indicate the tendency that the R&D expenditures decrease the firm's return. *Here, we confirm the H1.1 assumption with precaution*.

Let us recall that the explanation of this result is due to the fact that the expenditure of R&D, entered as expenses in the income statement, burdens the net

income of the firm and/or comes to weigh down the balance sheet when they are capitalized (the correlation between these two variables is 0.173*, which authorizes us to proceed to a multiple regression). When one considers the R&D to asset capitalization ratio (total assets/R&D expenses), the correlation is significant with an error threshold of 1% (-0.188**). This observation puts forward the importance attached by the stock market to the negative leverage effect of capitalized R&D expenditures. This variable has a strong correlation with the two variables previously studied. Thus, the more one firm chooses an intense capitalization of its R&D expenditures to the total asset, the lower the stock return is *(H1.2 confirmed)*.

The best way to describe this is with the intangible operating ratio (intangible assets /EBIT) that seems to signal the best the return. The correlation is –0.234** and is significant with an error threshold of 1%. The firm announces its capacity to generate benefits for the shareholder, providing that its EBIT is high compared to the intangible assets. This observation shows that the firm fully makes use of its intangible assets by exploiting them commercially. *(H1.3 confirmed)*.

Let us note that the intangible operating ratio is strongly correlated with the R&D to intangible capitalization ratio (0.709**) and with the R&D expenses ratio. On the other hand, the intangible operating ratio is not highly correlated with the R&D to asset capitalization ratio (0.145*).

When one regresses the intangible operating ratio and the R&D to asset capitalization ratio with the stock returns, we can only explain 3.6% of the variance. The estimated coefficients are not significantly different from zero. These results oblige us to reject the assumption, according to which there would be a combined effect of these two variables on stock returns. At this stage, we will retain that the more the firm has a high EBIT compared to its intangible assets, the higher the stock returns. The intangible operating ratio (Intangible assets/EBIT) is the product of the R&D expenses ratio and the R&D to intangible capitalization ratio (Intangible assets/R&D expenses x R&D expenses/EBIT). From this you can see that the stock returns of a firm increase with its capacity to generate benefits, by entering its expenditures in R&D as expenses in the income statement, rather than to capitalize them.

This assumption is confirmed when one regresses the R&D expenses ratio (R&D expenses/EBIT) and the R&D to intangible capitalization ratio (Intangible asset/ R&D expenses) with the return. The explained variance is 5.7% with an error threshold lower than 1%. The coefficients estimated for this regression are positive and significant with an error threshold of 1.4 %. The estimated coefficients show that the return is higher when the firm records its expenditure of R&D as expenses rather than as intangible assets and that the firm is capable to generate a high EBIT compare to its R&D expenses. This result demonstrates again that high-return companies have R&D programmes supported by the operating profits, rather than by the balance sheet. Problems of multi–colinearity do not authorize us to proceed to other multiple regressions.

Performing technological firms do not capitalize their entire R&D expenditures, because it is not very probable that all research is successful. On the other hand, when a firm has low R&D expenses compared to the size of its assets and when the firm has high R&D expenses compare to its EBIT, its net income can only be negatively

affected. Within this framework they would be start-up or large companies that have cumulated a delay as regards innovation compared to the market, or firms that have invested in unfruitful R&D. Indeed there are many scenarios where the R&D expenditures give rise to financial risks that we propose to analyze in the following section.

Table 4
Simple and multiple regressions between return and R&D expenditure variables

Ratio	Simple regression	Simple regression	Simple regression	Simple regression	Simple regression	Multiple regression	Multiple regression
R&D expenses ratio	-0.066 [0.015]					- 0.0 78 [0.004]	
Firm Intangibility		-0.009 [0.754]					
R&D to Intang. capitalization ratio			-0.047 [0.046]			-0.057 [0.014]	-.017 [0.53]
R&D to total assets capitaliz. ratio				-0.09 8 [0.006]			- 0.0 82 [0.055]
Intangible operating ratio					-0.066 [0.001]		
R2	0.026	0.022	0.019	0.035	0.055	0.057	0.036
Adjusted R2	0.023	0.000	0.014	0.031	0.05	0.048	0.027
F	6.036	0.098	4.030	7.663	12.19	6.299	3.896
Significant	[0.015]	[0.754]	[0.046]	[0.006]	[0.001]	[0.002]	[0.022]

3. R&D expenditures and the risk of the technological firms

We observe a positive relationship between the R&D expenses ratio (R&D expenses/EBIT) and the risk measured by the beta, since the coefficient of correlation is 0.33 and is significant with an error threshold of 1 %. The R^2 of the simple regression between beta and the R&D expenses ratio is 0.11^{**}. Indeed, the market would tend to consider the firms that show large expenses in R&D compared to the EBIT as being riskier. This is due to the fact that these firms would have multiple options of economic exploitations of this research in the future (real options). However, the fact that they are not marketable immediately generates a doubt about the economic effectiveness of this research and thus the perceived risk by investors. *(H2.1 confirmed).*

It is noticed that the variable intangibility of the firm measured by the ratio total assets/intangible assets maintains a strong positive correlation (0.765^{**}) with the variable "R&D to intangible capitalization ratio". In other words, when the firm records significant expenditure of R&D in the income statement, rather than in the balance sheet, it has few intangible assets compared to the total assets. It is thus noted that more

the firm records significant expenditure in R&D as expenses, the less it appears to be intangible.

If we do not find a relationship between the intangibility of the firm and its risk, it is not the same with its R&D to total asset capitalization ratio. The more the expenditures of R&D recorded as expenses are significant, compared to the total assets (low R&D to total asset capitalization), the less risky the firm appears *(correlation of 0, 211** and H2.2 is confirmed).*

The correlation which characterizes the relationship between the variables "R&D expenses ratio" and "R&D to intangible capitalization ratio" is –0.173 and significant with an error threshold of 5 %. This correlation is statistically very weak and we proceed to a multiple regression in order to examine whether it is possible to improve the results previously obtained. As the correlation between the variables "R&D expenses ratio" and "R&D to total asset capitalization ratio" are very significant (-0.447**), we cannot proceed to multiple regressions.

When we regress the variables "R&D expenses ratio" and "R&D to intangible capitalization ratio" we find a clear improvement of the explained variance of betas: 12.6%. Although the F test is significant with the threshold of 1%, the coefficient of the variable "R&D to intangible capitalization ratio" is not statistically significant.

The product of the two ratios can be rewritten as the intangible operating ratio: "intangible assets/EBIT". This ratio has a close relationship with the beta since the correlation is 0.286 (R^2=0.082). Indeed, the firm is riskiest when its EBIT is low compared to its intangible assets. *(H2.3 is confirmed).* In this case, the market can be interpreted as having a low EBIT for high intangibles that is dangerous for technological companies. It would mean that in spite of, for example, the development of new patented products or the acquisition of brands, it puts doubt on the opportunities for the firm to exploit economically its assets, thus generating a source of risk.

As we previously mentioned, when we regress the variable "intangibility of the firm" to the beta, we obtain a R^2 of 0.009 and none of the statistic tests validate a significant relationship between these two variables. This result indicates that the variable measuring the intangibility of the firm is not an indicator of the risk for technological firms when it is taken independently of other variables. On the other hand, this ratio takes all its meaning, when it is aggregated with the variable "R&D expenses". The R^2 is then 0.134. The tests of Fisher and Student are all significant. The coefficient of correlation between the two explanatory variables being slightly significant (0.139*). From this, we deduce that the beta increases as the firm has increasing R&D expenses and decreasing intangible assets to total assets (the coefficient of this last variable being negative). It is thus observed that a firm can compensate with intangibles for the risk generated by its R&D expenses. The explanation that we can give for this is due to the fact that capitalization tends to reduce the informational asymmetry of innovating firms. This is because an intense control is then exerted, contrary to the expenditure of R&D, which is more abstract in its interpretation. The expenditure in R&D capitalized in the balance sheet is then perceived as a source of competitive advantage. The risk of a firm increases with high R&D expenses and low intangible assets to its total assets.

The last two results obtained are significant because they confirm the assumption according that stakes that a technological firm announces the quality of its research programmes by the capitalization of its expenditure in R&D, while being able to generate a consequent EBIT. This means that the technological firms reduce the asymmetry of information by adopting this strategy, because it shows that it is able to draw part of its intangible assets. A firm that would only capitalized little of its expenditure in R&D, would tend to signal to the market that its research programmes are only slightly effective.

Table 5
Simple and multiple regressions between risk beta and R&D expenditures variables

Ratio	Simple regression	Simple regression	Simple regression	Simple regression	Simple regression	Multiple regression	Multiple regression
R&D expenses ratio	0.092 [0.000]					0.028 [0.000]	0.099 [0.000]
Fim Intangibility		- 0.02 7 [0.171]					-0.042 [0.026]
R&D to Intang. capitalization ratio			0.013 [0.431]			0.099 [0.079]	
R&D to total assets capitaliz. ratio				0.078 [0.002]			
Intangible operating ratio					0.057 [0.000]		
R2	0.11	0.009	0.003	0.044	0.082	0.126	0.134
Adjusted R2	0.106	0.004	0.002	0.04	0.078	0.118	0.126
F	26.04	1.889	0.622	9.785	18.862	15.077	16.144
Significant	[0.000]	[0.171]	[0.431]	[0.002]	[0.000]	[0.000]	[0.000]

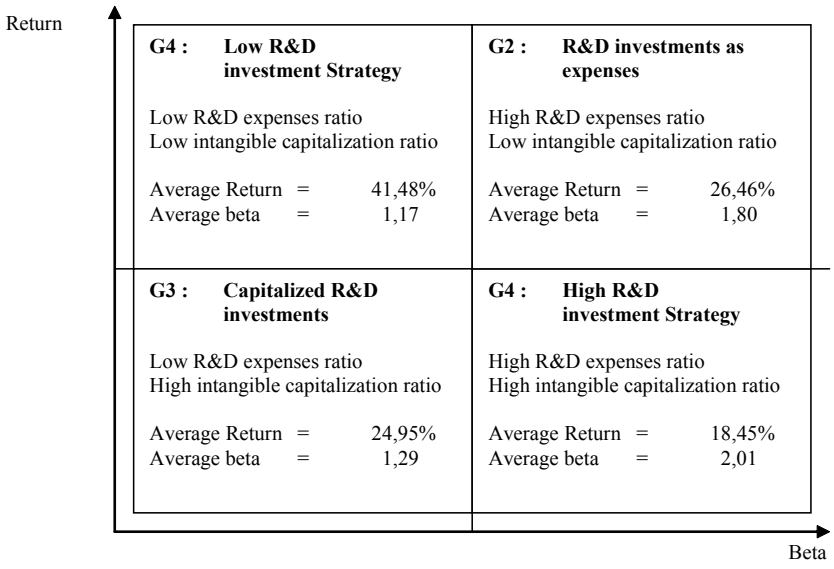
4. Tests of differences of the averages

After identifying the two variables, “R&D expenses ratio” and “R&D to intangible capitalization ratio”, as having jointly an incidence on the technological firm’s stock return and risk, we now propose to measure the impact of these variables on our sample, divided into four groups. These groups where made by splitting our variables at the median.

The following graph represents the financial performances of the technological firms according to their investment strategy in R&D. We observe that the market gives a very high risk to the innovating firms, which are characterized by an intense strategy

of R&D (Group G1). Beta is close to two times higher compared with the firms that have a low strategy of R&D (Group G2), since it passes on average from 2,01 to 1,17.

Graph 2
Investment strategy in R&D and financial performances of the technological firms



When we study the differences of the averages of the two groups, which are clearly different in terms of investment strategy in R&D (G1 group has a very strong strategy of R&D investment compared to the G4 group), we obtain the following results:

Table 6
Differences of the averages between the groups G1 and G4

	Group	N	Average	Standard deviation	Average standard error
Beta	1	64	2.0101	1.1747	0.1446
	4	42	1.1716	1.1409	0.1760
Return	1	66	0.1845	0.5184	0.0628
	4	41	0.4148	0.6848	0.1069

Table 7
Test of independent samples

		Test of Levene on the equality of the variances		Test-T for equality of the averages						
		F	Sig.	T	ddl	Sig. (bilat.)	Average diff.	Diff. st. deviation	Interval (1) Inf.	Interval (1) Sup.
Beta	AEV (2)	.575	0.45	3.656	106	0	0.8384	0.22931	0.3838	1.293
	AEV			3.68	89.333	0	0.8384	0.22782	0.3858	1.291
Return	AEV	2.503	0.117	-1.988	107	0.049	-.2304	0.1159	-.4601	-.0006
	AEV			-1.857	67.597	0.068	-.2304	0.12406	-.4779	0.017

(1) Confidence interval: 95% of the difference. (2) AEV: Assumption of equal variances.

The Levene test of equality of the variances allows us to consider that the distribution of the betas of the two groups have a similar shape. This is also observed by the proximity of the standard deviations when they are squared. Consequently, the test of the differences of the averages is interpreted with the estimated parameters, which consider the equality of the variances. The statistic t (p value) is 3.65 and has a probability of 0.000. We can conclude that the averages of the betas of the two groups are significantly different.

We also observe that returns are double for the firms with a low investment strategy in R&D (18.45% vs 41.48%). The test of differences of the averages is, however, less conclusive because we are prepared for the possibility of considering an equality of the variances and in fact to consider that our averages are statistically different with an error threshold lower than 5%.

However, the survival of the technological firms cannot always ignore investment in R&D and it appears preferable to capitalize the R&D expenditures. If the test of differences of the averages on returns is not significant between groups G2 and G3 (respectively 26.46% and 24.95%), it is the opposite for the betas. The average beta is 1.29 for the firms, which capitalized their expenditure in R&D and 1.8 for the firms that enter their expenditure in R&D as expenses. This difference of the averages is significant with an error threshold of 2%. Thus, for an almost equal return, it is preferable to capitalize the expenditure in R&D because the perceived risk of the firm by the market will be reduced. Let us notice that this difference is even stronger between the firms of groups G1 and G3, since the capitalization strategy lowers the risk from a beta of 2.01 to 1.29. The test of the differences of the averages is significant with an error threshold of 1% on the betas, whereas it is not significant on the returns.

A strategy of capitalization has consequently a decisive impact on the financial performance of technological firms. The explanation, according to which the accounting rule of capitalization (IAS 38 standard) limits drifts, signals the control of

technology and contributes to reduce the uncertainties and risks of the business plan, is confirmed through our empirical analyses.

IV. CONCLUSION

The growth of technological firms relies on its opportunities to exploit innovative products and services, thus forcing them to strongly invest in research and development (R&D). Our results show that R&D expenditures signal the strategic positioning of a firm and significantly put strain on the financial performances.

We define companies with intensive investments in R&D as companies that have a high R&D expenses ratio (R&D expenses/EBIT) and a high R&D capitalization ratio (Intangible assets/R&D expenses). We have observed that the beta is nearly two times higher, and the return nearly two times lower for companies with intensive investments in R&D, compared to low R&D investing companies. Indeed, firms with an intensive investment strategy in R&D have significantly lower financial performances.

Nevertheless, rules of R&D capitalization seems to limit the information asymmetry between technological firms and the exchange market, because firms with a high R&D capitalization ratio (Intangible assets/R&D expenses) have lower betas. Financial performances hold so long as the company generates important earnings. If not, it appears that the more a firm capitalizes its R&D expenditures, the more it increases its intangible assets. So, the capitalization of R&D weighs down the balance sheet and has a negative leverage effect on the returns.

R&D, being impossible to avoid for some technological firms, our results show that it is preferable to capitalize the R&D expenditures if the firm is able to draw an immediate commercial exploitation from them. In this case, where the benefits are expected in the future, the R&D expenditures will have a strong negative impact on the financial performances. It is then preferable to externalise projects (spin-off), which require significant investments in R&D, rather than to develop them in-house.

While talking about their patents, brand and know how, Bill Gates said about Microsoft: “our primary assets do not show up in the balance sheet at all.” The observation we made from this article might contribute to the explanation of the current spin-off trend in technological groups and why annual reports do not have much affect on.

ENDNOTES

1. The IAS 38 standard distinguishes two phases in intangible assets creation: the research phase and the development phase. R&D expenditures of the first research phase are expenses, but R&D expenditures of the development phase can be capitalized, i.e. these expenditures are counted as an intangible asset if the firm shows: (A) the technical feasibility of the asset for its start-up or of its sale, (b) its intention to use it or sell it and (c) the resource availability, in particular technical and financial resources, for its development and use.
2. Our original sample is composed of a total of 365 European firms. 194 of them are within the software sector, 73 in the telecommunications, 68 in the aerospace and

30 in biotechnologies. Initially, we refined the composition of the sample by excluding the 108 firms whose earnings, before interests and taxes, are negative because the ratios necessary for our analysis are not interpretable when they are negative. For the same reasons, we excluded the 23 firms that have a negative recorded value of their intangible fixed assets. Our sample is then made up of 234 firms. Secondly, after a logarithmic transformation of our data, we excluded the firms with extreme values. That is to say, we excluded 21 firms, so our final sample was composed with 213 firms.

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