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The Performance of Top R&D Investing Companies in the Stock Market

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The present Working Paper (No. 14/2009 – September 2009) is issued in the context of ***the Industrial Research Monitoring and Analysis (IRMA)***[1] activities that are jointly carried out by the European Commission's Joint Research Centre (JRC) – Institute for Prospective Technological Studies (IPTS) and the Directorate General Research - Directorate C, European Research Area: Knowledge-based economy.

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[1] IRMA activities correspond to the implementation of the approach set out in "Investing in research: an action plan for Europe" (COM, 2003) and in further Communications of the Commission: "More Research and Innovation – Investing for Growth and Employment – A common approach", COM (2005) 488 final, "Implementing the Community Lisbon Programme: A policy framework to strengthen EU manufacturing – Towards a more integrated approach for industrial policy", COM (2005) 474 final.

Abstract

Based on an original data set with information of a representative portfolio of among the largest 304 Research and Development (R&D) investing companies over the 2003-2006 period, the overall analysis, except in a few cases, gives some robust evidence of a positive relationship between top R&D-investing companies and their performance in the stock markets as measured by the evolution of their market capitalisations' values.
In terms of sectors, companies in the pharmaceuticals and biotechnology and software & computer services sectors in the UK and the chemicals sector in Germany appear to outperform the respective sectoral stock market indexes in which they operate. On the other hand some other sectors, such as technology hardware and equipment one in France, show an underperforming behaviour.
Empirical findings from the econometric analysis suggest a positive impact of the firm's R&D intensity on its market capitalisation performance.
Besides some data limitations which call for further investigations, R&D investment can without uncertainty be acknowledged as representing an important strategic element for companies' economic and financial performance, but is not the only one. To name a few of them, framework conditions in the economy, marketing activities and the level of market power of companies are only other important factors that have an impact on companies' performances which are also reflected on their stock markets values.

JEL Classification: G30, L60, O31

Keywords: top R&D firms, market capitalisation performance, R&D intensity, size of R&D investments.

1 Introduction

The linkage between companies' margins, profitability, market capitalisation, market share, productivity and other performance measures and their R&D investment has been addressed by many authors. Besides, the relation of companies' share values with R&D investment, if proved, can represent one of the most precious elements for both companies and investors' strategic decisions. Nonetheless, the literature addressing this particular aspect has brought sometime divergent results; main reasons being the scarce homogeneity of samples analysed, different methodologies used and/or outcome based on anecdotal evidence.

This paper presents the result of an investigation based on the stock market performance of 304 top EU R&D investing companies listed on the main EU stock markets. In particular, we are interested in comparing the market capitalisation evolution of these large R&D firms with the corresponding stock market and sector indexes in which they are listed as well as in examining the relationship between firms' R&D investment and intensity and their stock market performance. The study focuses on a 4 year-period of observation (2003-2006).

The results show that in most cases, the R&D portfolios values (top R&D-investing firms of the sample analysed) are higher than the corresponding figures at the aggregated level (all shares stock or sector) hence indicating that the firms of the R&D portfolio are outperforming most of the other firms in a given stock market or sector.

The paper comprises a brief literature review, the methodological framework, a descriptive analysis at stock market, sectoral and firm levels and the concluding remarks.

2 R&D, economic and stock market performance: A brief literature review

The present literature dealing with this complex subject does not provide always convergent conclusions.

The measurement of a broad number of performance factors at the company level has been addressed by many authors. McGrath and Romeri (1994) report on the validation of a R&D

Effectiveness Index[1] through a study of 45 electronic systems companies. They found a strong relationship between the R&D Effectiveness Index and other business performance factors and believe that the approach can be used to compare performance, measure improvement, and evaluate business units.

The link between R&D investment and productivity (as a proxy for business performance) has been approached in many econometric analyses (Griliches, 1995). Klette and Johansen (2000) used data from the Statistics Norway and from the R&D survey covering the period 1980-1992 and the four most representative sectors for R&D investment. Their estimates show a significant positive effect of R&D on firm performance. More recently, Ortega-Argilés *et al.* (2009) used both European sectoral OECD data over the period 1987-2002 and a unique micro longitudinal database consisting of 532 top European R&D investors over the six-year period 2000-2005 for analysing the same relationship. One of the main conclusions of their study is that the R&D stock has a significant positive impact on labour productivity in high-R&D intensity sectors, the same significant impact was not found in the low-R&D intensive ones.

Besides firms' own R&D stocks, Aldieri and Cincera (2009) find that geographic and technological based R&D spillovers stocks have important and positive impact on the productivity growth of firms. The effects of the pure technological externalities on firms' economic performance appear to be higher as compared to the geographic spillovers. This finding suggests that the technological proximity is more important than the geographic one for the impact of R&D spillovers on firms' productivity growth.

Contrary to prevailing wisdom, Jaruzelski *et al.* (2005, 2006, 2007) suggested that 118 of the top 1000 R&D performing companies worldwide ('High-Leverage Innovators'- HLIs) apparently achieve leading business performance (measured as margins, profits, sales and shareholder returns) but with below-average R&D intensity for their sector and that 'lavish R&D budgets do not guarantee performance'.

[1] McGrath and Romeri (1994) have developed an R&D effectiveness index (EI) for measuring the overall success of product development of firms:

$$EI = \frac{NPR \times (NP + RD)}{RD}$$

where: NPR = New product revenues, NP = Net profit and RD = R&D investments.

Tubbs (2008) has also examined this question and has found that if companies are classified in the 39 ICB sectors, instead of the 10 sectors as Jaruzelski *et al*. (2007) used, only 13 companies out of the 1000 could be indicated as HLIs.

As emphasised by Tubbs (2007) and Fontagné *et al*. (2008), the statistical approaches that attempt to associate R&D and business performance are sensitive to a number of relevant factors which can complicate the analysis. These include, sectoral differences, size effect, business cycle, mergers & acquisitions, product development times, impact of other intangibles (marketing, design, quality of management).

Hall *et al.* (2007) approach this issue by studying the relationship between European firm's stock market value, patents and R&D. Analyzing the private value of patents issued by the European Patent Office (EPO) and the US Patent and Trademark Office (UPTSO) during the period 1991-2004, they demonstrate very clearly that firms' stock market values are influenced by those patents obtained by EU firms in both European and US jurisdictions. Other studies (e.g. IMF, 2007; Hall and Oriani, 2006; Bosworth and Rogers, 1998) which are based on national statistical data, focus on the link between companies' R&D and their stock market value. They conclude that this relationship is positively valued by financial markets in addition to physical assets.

Similarly, the UK Department for Business Enterprise & Regulatory Reform (BERR: 2007, 2008) approaches the issue using firms' data from publicly available corporate annual reports for companies listed in London Stock Market Exchange observed during the period October 1997 to October 2007. They conclude that firms listed in the FTSE100[2] with higher R&D intensity (R&D investment as a proportion of sales) have been judged by the market to be more successful in terms of nominal share prices (un-weighted with market capitalisation data) growth over the recent past than the stock market index as a whole.

3 Research questions, data and methodological framework

The study aims at addressing two basic questions: How is the performance of top private EU R&D investors in the Stock Market? Can a relationship be observed between the growth of the company R&D investment, its R&D intensity and its market capitalisation growth?

[2] The FTSE 100 is a share index of the 100 most highly capitalised UK companies listed on the London Stock Exchange.

Of course, these questions are different in the substance and approach to address them to those that motivate a given investor who would like to build a portfolio with shares of companies that responds to the risk propensity of the portfolio's owner and to a large numbers of economic and financial parameters (among these parameters it might also be considered the level of companies' of R&D investment), thus which is most likely to provide the highest investment returns.

The data gathered for the purposes of the present analysis have been collected from Reuters 3000Xtra. The data set contains information concerning the share prices[3], the sector index values, and the main stock market index value of a portfolio of the 500 largest EU R&D performing companies. Yearly data of their R&D investments, R&D intensity and sales were collected from this and previous editions of 'The EU Industrial R&D Investment Scoreboard' (2004-2008 editions)[4]. This data set has been completed with yearly information on the stock market capitalisation of companies over the period 2003-2006 which shrinks the final dataset used for the analysis to 304 top EU R&D-investing firms. These companies in 2006 represented about 78% of the total R&D investment of the top 1000 EU R&D companies as reported in the 2007 R&D Scoreboard[5]. Further information on data capturing methodology, data limitations, the sectoral classification used and the glossary of terms are described in Annex I.

The approach implemented in this analysis consists in comparing the evolution over time of the stock market performance of a given stock market or sectoral index against the performance of a representative portfolio of the largest R&D companies. While similar to the one pursued by the authors of the UK R&D Scoreboard (BERR, 2007) and now by the Department for Innovation, University and Skills (DIUS), the main differences between the two approaches are the stock markets selected, the number of companies composing the R&D portfolios[6], and the stock market performance indicator. Rather than considering the un-weighted share prices evolution of R&D firms (BERR 2007, 2008), the stock market performance measure adopted in this paper rests on market capitalisations. These market capitalisation values based indexes allow one to control for the size (share price multiplied by the number of shares issued) of the firms composing the R&D portfolios, the stock market or the sector considered. A second advantage of using market capitalisations over share prices

[3] Stock prices being based on expectations on future cash flows can be also used as a proxy of the growth of company's earnings, as earnings are often the single most important determinant of a stock's price.
[4] http://iri.jrc.ec.europa.eu/research/scoreboard.htm
[5] See Table A1.1 in Annex A1.7.
[6] The R&D portfolio considered in the UK R&D scoreboard is composed of the FTSE100 firms spending at least 4% of their sales on R&D. The value of the R&D portfolio has been constructed as the sum of share price of each share in the portfolio.

is that the former avoid changes in values due to stock consolidations, e.g. stock split or reverse split[7].

It should also be noted that while the number of firms for the different R&D portfolios is kept fixed over time[8] in order to avoid variations in performances which are only due to changes in firms' sample composition over time, this is not the case for the stock market and sector based indexes. Given the churning, due to joiners and leavers, the number of firms in a given stock market or sector will not be the same every year[9] and hence the comparison is somewhat compromised. However, it should be noted that most stock market and sector based indexes are adjusted to account for these changes in the firms' compositions[10].

4 Descriptive Analysis

4.1. Overview at the aggregated stock market and sector levels

Considering the performance's evolution of all share and sectoral indexes in terms of market capitalisation in four European stock markets,[11] it is observed that in a majority of cases a positive trend emerges over the period analysed[12]. While these trends vary according to sectors and countries, several technology/R&D intensive sectors seem to underperform when compared with the general main stock market index of countries. Noticeable exceptions are the electronics and electrical parts sector in the UK and the pharmaceuticals and biotech sector in Denmark. Figures 1 and 2 provide an illustration of these trends for the two main European stock markets, namely Germany and the UK[13].

[7] For instance, a company which undergoes a stock split of 1:2 and as a result its price changes from 1 Euro per share to 0.50 Euro per share, although no real value change of the company occurred (the only difference is that the company had 100 shares now it has 200 shares).

[8] To insure a minimum degree of representativeness, we only consider the sectors for which at least five companies are available in the R&D portfolios for each year of the period investigated.

[9] For instance in the FTSE All Share automobiles and parts index, there has been 8 firms leaving and 14 joining this index from 2000 to 2007.

[10] For a discussion see for instance:
http://www2.standardandpoors.com/spf/pdf/index/Index_Mathematics_Methodology_Web.pdf

[11] DAX Composite (DE), FTSE all share (UK), OMX Copenhagen and OMX Stockholm. Note that for CAC40 (FR) data for the all share market capitalisation index only cover the period from 2005 onwards while no data are available for AEX all share (NL), Brussels SE Cash, MIBTEL General Index (IT) and Madrid SE General.

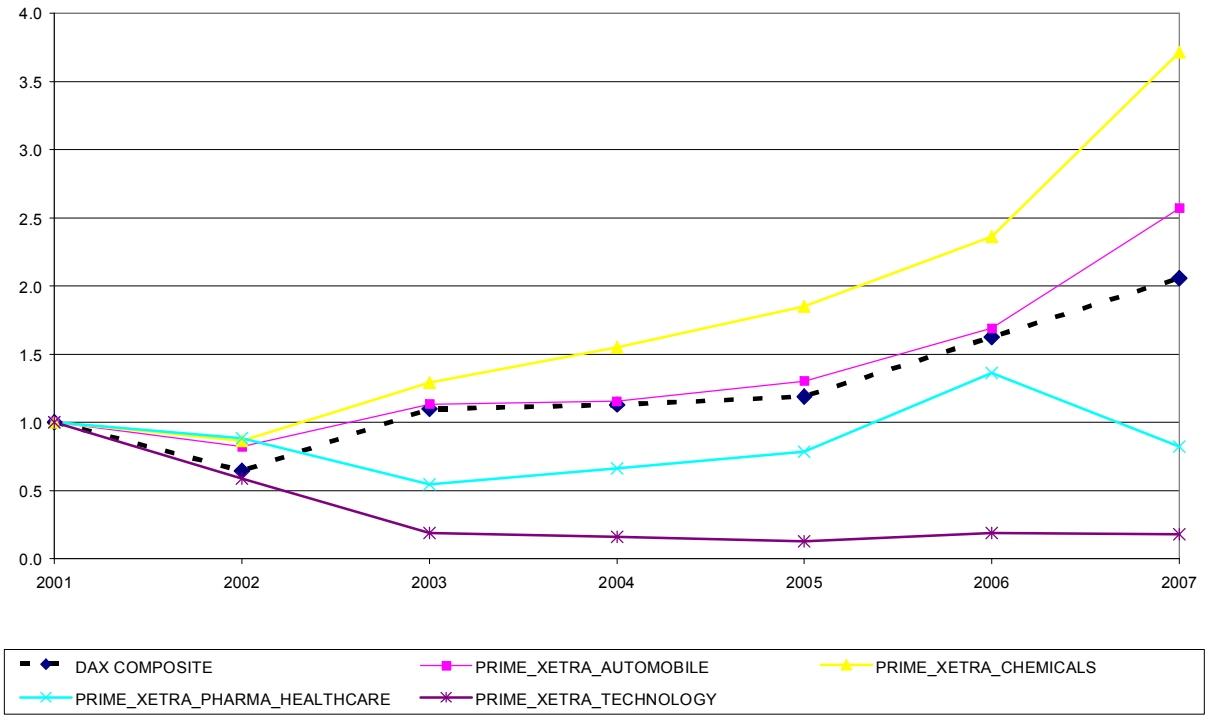
[12] See table A2.1 in annex II. On the other hand, PRIME_XETRA_PHARMA_HEALTHCARE, PRIME_XETRA_TECHNOLOGY and FTSE_ALL_SHARE_TECHNOLOGY_HARDWARE experienced a decrease of their market capitalization index over the period.

[13] Note that data on market capitalisation indexes are available from 2001 for Germany and 2004 for the UK.

Two main reasons can be put forward for explaining why the general stock market index is generally outperforming most sectoral indexes and in particular the technological and most R&D intensive sectors. First, general stock market indexes are in general dominated by two major industry sectors: financials and oil and gas[14]. Second, following the unprecedented rise in the period examined in commodity prices as well as in market capitalisations of banks and other major actors in the financial sector which led to the current financial bubble burst, companies listed in these two sectors have experienced very strong returns over the recent years and are most likely outperforming the other companies in terms of their market capitalisation values.

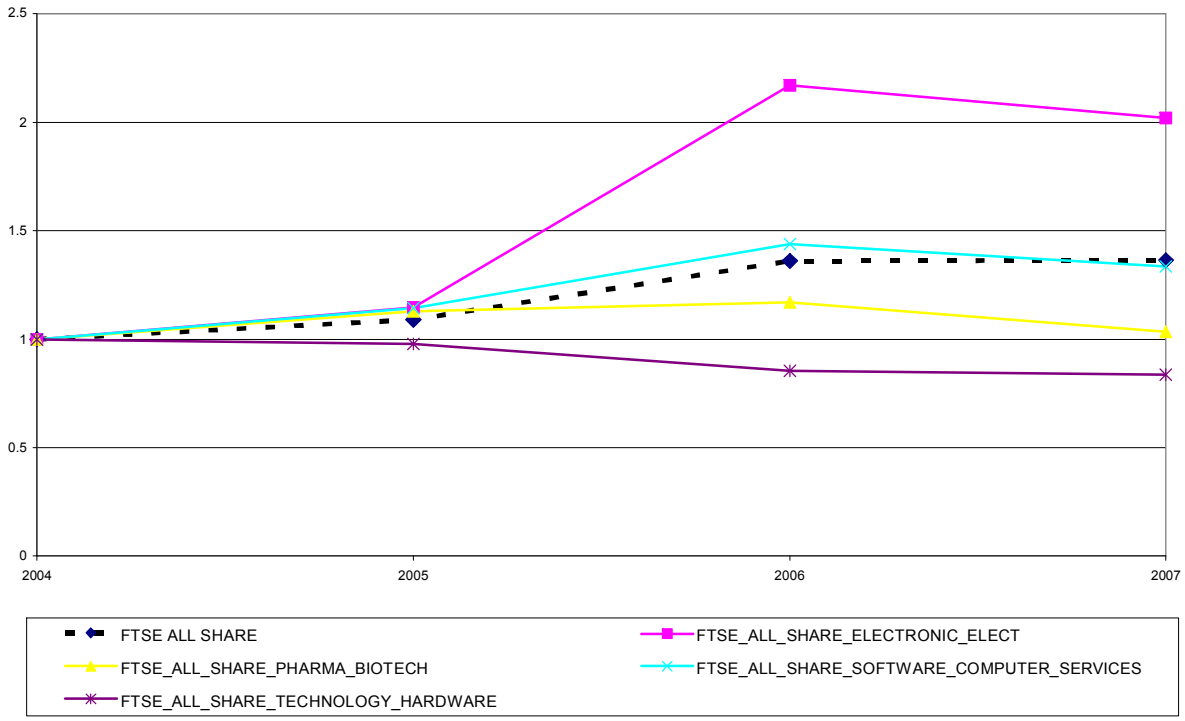
Therefore, to shed further light on the R&D-stock market performance relationship, section 4.2 compares the stock market and sectoral indexes with the ones pertaining to representative samples of R&D companies over the recent period.

Figure 1. Evolution of selected stock market and sector indexes based on market capitalisation in Germany (2001 = 1)



[14] For instance in August, 31, 2007, these two sectors accounted for 44.88% of the value of the FTSE 100 in terms of market capitalisation.
(source: http://www.ftse.com/Indices/UK_Indices/Downloads/FTSE100_Index_Factsheet.pdf)

Figure 2. Evolution of selected stock market and sector indexes based on market capitalisation in the UK (2004 = 1)



4.2. Market capitalisation performance of Stock market and R&D portfolio firms

Tables 1 and 2 illustrate the evolution over the recent period of the values in terms of market capitalisation of different European stock markets (table 1) and sectors (table 2) and the corresponding aggregated value (the sum of market capitalisation values) of representative samples of R&D companies (hereafter referred as to R&D portfolios) derived from the data set of the top 304 EU R&D firms[15].

To facilitate the comparison of the performance's evolution of R&D performing company portfolios, stock markets and sectors, the right hand side parts of tables 1 and 2 present the series in a normalized way (index = 1 for the first available year of data). It follows that in most cases, the R&D portfolios values are higher than the corresponding figures at the aggregated level (all shares stock market or sector) which indicates that the firms of the R&D portfolio are outperforming all firms in a given stock market or sector.

[15] Tables 1 and 2 also indicate the share of the R&D portfolios' market capitalisation with respect to the stock market or sector total. The second column of each table provide the number of companies composing the R&D portfolios and the stock markets or sectors.

In some cases where the R&D portfolio firms are underperforming the stock markets or the sectors in terms of their market capitalisation performance, one possible interpretation to explain these cases is that there are a few (very) large companies in terms of market capitalisation in the stock market that are not part of the R&D portfolio and that are outperforming the other firms. A question which arises is whether these large companies performing well in the stock-market are indeed not investing (very much) in R&D?[16] This is for instance likely to be the case for the firms that belong to the financial and oil and gas sectors. That is to say, even if these firms invest in R&D, they probably do not invest a lot in these activities. It could also be the case that these firms are able to absorb innovation performed outside the company or maybe because of simple classification (miss)displacement or representativeness of the R&D portfolio. Due to data limitations, this question is not addressed in this study.

At the stock market level, as can be seen from table 1, firms listed in the Danish and German stock exchanges (OMX Copenhagen Price Index and DAX Composite) are outperformed by the ones composing the Danish and German R&D portfolios, i.e. this concerns 18 and 62 R&D companies. An opposite finding is observed for the other stock markets, i.e. France and the UK while no clear-cut conclusion can be drawn for the Swedish stock market. For the UK at least, this result can again be explained by the importance of the financial and oil and gas sectors in the stock market value by market capitalisation.

Table 2 presents the results at the sectoral level. Note that the main advantages of performing the analysis at the sectoral level are twofold. First the degree of heterogeneity of the firms composing both the sectors and the corresponding R&D portfolios is lower. Second, working at that level allows one to address the issue of the influence of the financial and oil and gas sectors on the overall market performances.

[16] If this would be the case, they should normally appear in the EU top 1000 R&D scoreboard. Note that knowing the composition of the firms listed in stock markets and comparing these firms with the ones included in the top 1000 R&D scoreboards would allow one to give a precise answer to this question.

Table 1. Stock market vs. R&D portfolio firms performance in terms of market capitalisation

Stock market index			2003	2004	2005	2006		2003	2004	2005	2006
CAC All Share	49	MCP	427778	612391	623349	736595	-	1	1.43	1.46	1.72
		MCP								1	1.18
	470	MCI			1668770	2339460				1	1.40
		%			37	31					
DAX Composite	62	MCP	367062	511555	563559	751437	+	1	1.39	1.54	2.05
	664	MCI	1097014	1128917	1189291	1623685		1	1.03	1.08	1.48
		%	33	45	47	46					
FTSE Techmark All Share	74	MCP	841045	1057668	1142899	1347335	-	1	1.26	1.36	1.60
		MCP							1	1.08	1.27
	521	MCI		2760872	3010069	3755228			1	1.09	1.36
		%		38	38	36					
OMX Copenhagen_PI	18	MCP	27103	33557	44895	64381	+	1	1.24	1.66	2.38
		MCP							1	1.34	1.92
	208	MCI		186943	214422	281478			1	1.15	1.51
		%		18	21	23					
OMX Stockholm_PI	29	MCP	100134	126404	138162	202779	=	1	1.26	1.38	2.03
		MCP							1	1.09	1.60
	293	MCI		472352	533245	748786			1	1.13	1.59
		%		27	26	27					
AEX All Share	14		60527	79108	87294	104985		1	1.31	1.44	1.73
Brussels SE Cash Market Return	11		27195	42120	48871	63569		1	1.55	1.80	2.34
Madrid SE General	5		79408	102481	100118	135545		1	1.29	1.26	1.71
MIBTEL General	9		139710	189766	192937	209282		1	1.36	1.38	1.50
OMX Helsinki_PI	17		76519	105162	121403	162475		1	1.37	1.59	2.12
Wiener Boerse	5		12367	23699	29962	34606		1	1.92	2.42	2.80

Notes:

- MCP = market capitalisation (sum) of the R&D portfolio's companies; MCI = Market capitalisation of the stock market or sector. *MCP* = normalized (first year =1) index market capitalisation of the R&D portfolio with same first year as MCI. In red colour the number of firms included in the R&D portfolio. In **bold** the corresponding number of companies included in the construction of the indexes. '**Green plus**' (resp. 'red minus' and 'gray equal') cells refer to stock markets where R&D portfolio firms are out-(resp. under- and equally-) performing as compared to the overall stock market index.
- "%" represents the percentage of MCP with respect to MCI.
- For the last six stock markets, market capitalisation all share indexes (MCI) are not available.

Table 2. Sector vs. R&D portfolio firms performance in terms of market capitalisation

Index sector			2003	2004	2005	2006		2003	2004	2005	2006
CAC Technology Hardware & Equipment	6	MCP	26520	27824	26489	36177	-	1	1.05	1.00	1.36
		MCP								1	1.37
	10	MCI			38753	63782				1	1.65
		%			68	57					
FTSE All Share Electronic & Electrical Equipment	9	MCP	5061	5970	6978	11108	-	1	1.18	1.38	2.19
	12	MCI	5581	7526	8629	16336		1	1.35	1.55	2.93
		%	91	79	81	68					
FTSE All Share Pharmaceuticals & Biotechnology	11	MCP	150752	167346	189787	174595	+	1	1.11	1.26	1.16
	17	MCI	232363	214351	241742	250777		1	0.92	1.04	1.08
		%	65	78	79	70					
FTSE All Share Software & Computer Services	9	MCP	7208	9386	10824	14460	+	1	1.30	1.50	2.01
	19	MCI	20084	20648	23580	29715		1	1.03	1.17	1.48
		%	36	45	46	49					
FTSE All Share Technology Hardware & Equipment	6	MCP	3157	4043	3931	4886	+	1	1.28	1.25	1.55
	9	MCI	9087	9564	9351	8157		1	1.05	1.03	0.90
		%	35	42	42	60					
PRIME Xetra Chemicals	7	MCP	51045	74791	82200	117500	+	1	1.47	1.61	2.30
	13	MCI	71626	85958	102685	131034		1	1.20	1.43	1.83
		%	71	87	80	90					
PRIME Xetra Industrial	14	MCP	66389	83604	91318	139201	+	1	1.26	1.38	2.10
	99	MCI	129761	143911	165495	223441		1	1.11	1.28	1.72
		%	51	58	55	62					
PRIME Xetra Pharma & Healthcare	10	MCP	11998	11320	32971	32839	+	1	0.94	2.75	2.74
	43	MCI	39927	48467	57174	99585		1	1.21	1.43	2.49
		%	30	23	58	33					
PRIME Xetra Technology	10	MCP	8601	8588	8682	11718	+	1	1.00	1.01	1.36
	26	MCI	16376	14053	11082	16315		1	0.86	0.68	1.00
		%	53	61	78	72					
Stockholm SE Capital Goods	13	MCP	39409	48856	61398	103886	=	1	1.24	1.56	2.64
	51	MCI	67100	85707	109109	176399		1	1.28	1.63	2.63
		%	59	57	56	59					

Notes:

- MCP = market capitalisation (sum) of the R&D portfolio's companies; MCI = Market capitalisation of the stock market or sector.
- In red colour the number of firms included in the R&D portfolio. In **bold** the corresponding number of companies included in the construction of the indexes. '**Green plus**' (resp. 'red minus' and 'gray equal') cells refer to sector stock markets where R&D portfolio firms are out-(resp. under- and equally-) performing as compared to the overall sectoral stock index.
- "%" represents the percentage of MCP with respect to MCI.

It follows that for a majority of sectors object of this analysis, namely pharmaceutical and biotechnology, software and computer services and technology and hardware equipment in the UK, chemicals, industrials, pharmaceuticals and healthcare and technology in Germany, top R&D firms are experiencing better performances in terms of the evolution of their market capitalisations over time. On the other hand, R&D firms belonging to the technology hardware and equipment sector in France and the electronic and electrical equipment sector in the UK are characterised by a lower growth rate of their market capitalisation as compared to all the firms in this sector.

An additional problem that we address rests in the possible discontinuities in the market capitalisation series over years. In particular, we identify the firms that encountered significant changes of the average annual growth rate of their market capitalisation values over the period investigated[17]. In practise, we removed all observations for this variable below the 5th percentile and the above the 95th percentile performed within each stock market or sector.

The results are presented in table A.3.1 (for the stock market indexes) and table A.3.2 (for the sectoral indexes) in Appendix III. It follows that the performance of the aggregated market capitalisation values of the firms composing the R&D portfolios is generally about the same order of magnitude as the one obtained when the below 5th and above 95th percentile observations are removed. When the differences between these two performances indicators are significantly different, the values taken by the second indicator tend to be lower, which indicates the presence in some R&D portfolios of companies performing very high. This in particular the case for the following stock and sectoral markets: FTSE all shares, FTSE electronic and electrical equipment and FTSE software and computer services for the UK, Madrid SE general for Spain, MIBTEL General for Italy, Wiener Boerse for Austria and PRIME Xetra industrial for Germany. In a few cases, a higher performance is observed when extreme values (again below and above the 5th and 95th percentiles respectively) are removed: CAC technology hardware and equipment for France and PRIME Xetra chemicals for Germany.

As an alternative indicator to assess the link between R&D and the stock market performance, the methodology implemented in the UK R&D scoreboard report (BERR 2007, 2008) has been considered as well. This methodology normalises to one the initial market capitalisation values of each R&D portfolios' firms and then compare their average values with the one of the corresponding stock market or sector over time. The main difference of this approach with

[17] These discontinuities can occur due to stock splits/reverse stock splits, takeovers, mergers and acquisitions or other such company events.

respect to the one we have introduced before is that it attaches the same weight to all companies composing the R&D portfolios. The results presented in tables A.3.1 and A.3.2 in Appendix III show that for a majority of cases, the normalized unweighted performance measures are higher as compared to the ones based on the other method. This result could be interpreted as reflecting a better performance of the smaller companies relatively to the largest ones that compose the R&D portfolios. Finally, it should be noted that the differences between the normalised and un-normalised performance measures are less pronounced when the most extreme values (below 5th and above 95th percentile observations) are removed.

So far, the results presented are based on a comparison of stock markets vs. sectoral as well as sectoral indexes vs. representative sample of R&D companies' performances in terms of their market capitalisation's evolution over the recent period. Section 4.3 tries to shed some more light on the R&D firms' performances for four selected sectors by looking at the evolution of the share prices and market capitalisation at the firm individual level.

4.3. Individual corporate behaviours

This section presents the evolution of companies' market capitalisations (over 2003-2006) from different R&D portfolios of selected sectors and complement previous approaches[18] by using information of individual firm R&D strategy within the group of analyzed firms, i.e. the average R&D intensity (2004-2006) and the rank position that the company has in terms of the size of its R&D investment in 2007[19] in order to analyse and contrast them with the sectoral index of the stock market where these firms are operating.

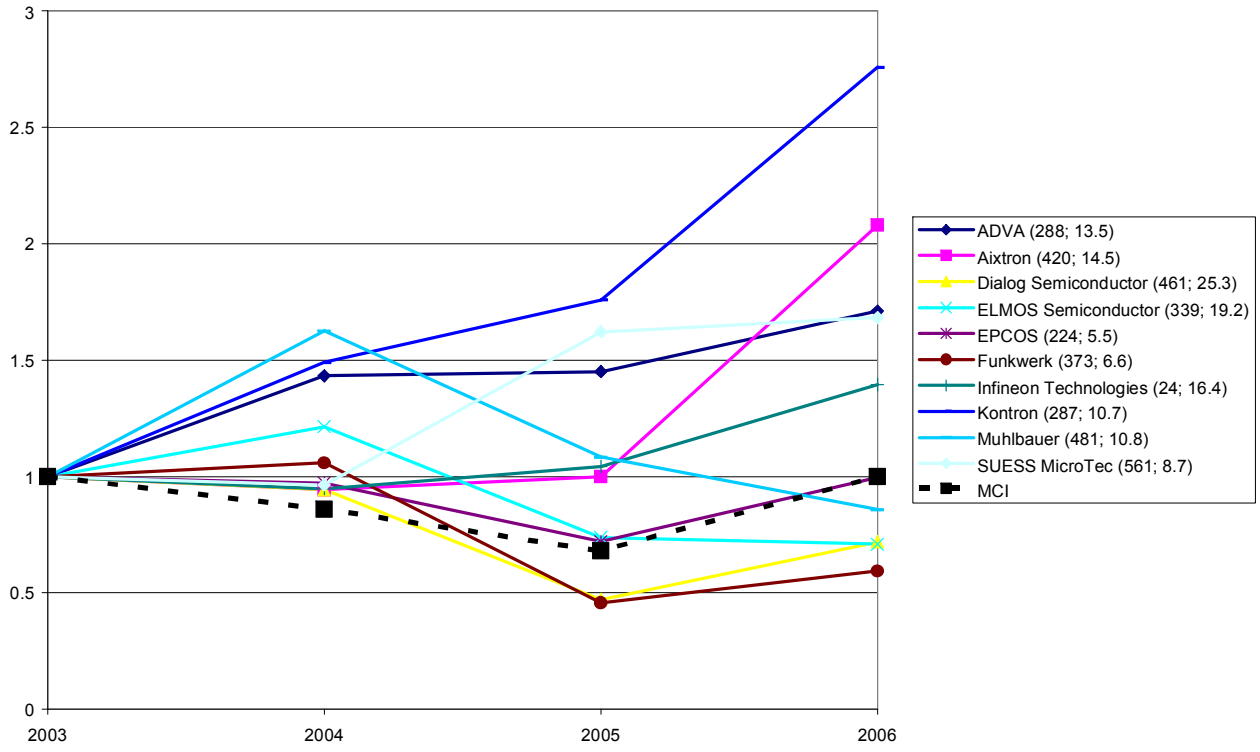
The graphical analysis has been reproduced for a set of different selected sectors to compare the heterogeneity between sectoral indexes and to draw some conclusions. In particular, four sectors have been retained to illustrate different cases according to whether R&D portfolios companies are out- or under-performing the corresponding sectoral all shares indexes or that no difference is observed between the two groups of firms. The chosen sectors are the following ones: a) the PRIME Xetra technology index operating in Germany under the DAX Stock Market, b) the FTSE all share software and computer services index, which is composed of firms operating in the UK in the FTSE stock market, c) the Stockholm SE capital

[18] Previous attempts in the literature use the price shares of companies as the proxy of firms' stock market performance (BERR, 2007 and 2008).
[19] The information concerning the R&D investment behaviour is provided in the legend of the graph.

goods operating in Sweden under the OMX Stockholm stock market and d) the FTSE all share technology hardware and equipment index.

Figures 3 and 4 illustrate the case where the R&D portfolios' firms outperform the sectoral index in terms of market capitalisation. Figure 3 concerns the PRIME Xetra technology index which covers a quite broad set of R&D scoreboard industry sectors, mainly the semi-conductors, telecommunication and electronic equipments sectors. To illustrate this case, we present the individual behaviour of 10 companies entering the composition of this sectoral index for the 2003-2006 period. Figure 3 also shows the evolution over the same period of the MCI, i.e. the market capitalisation value of the sectoral index which comprises 26 companies in total. As regards the MCI performance, it follows from table 2 that this sector is among the ones with the less favourable evolution. Furthermore this situation can no be explained by the presence of outliers as the value of the MCI when the below 5th and the above 95th percentile observations are removed is about the same (as can be seen from table A.3.2).

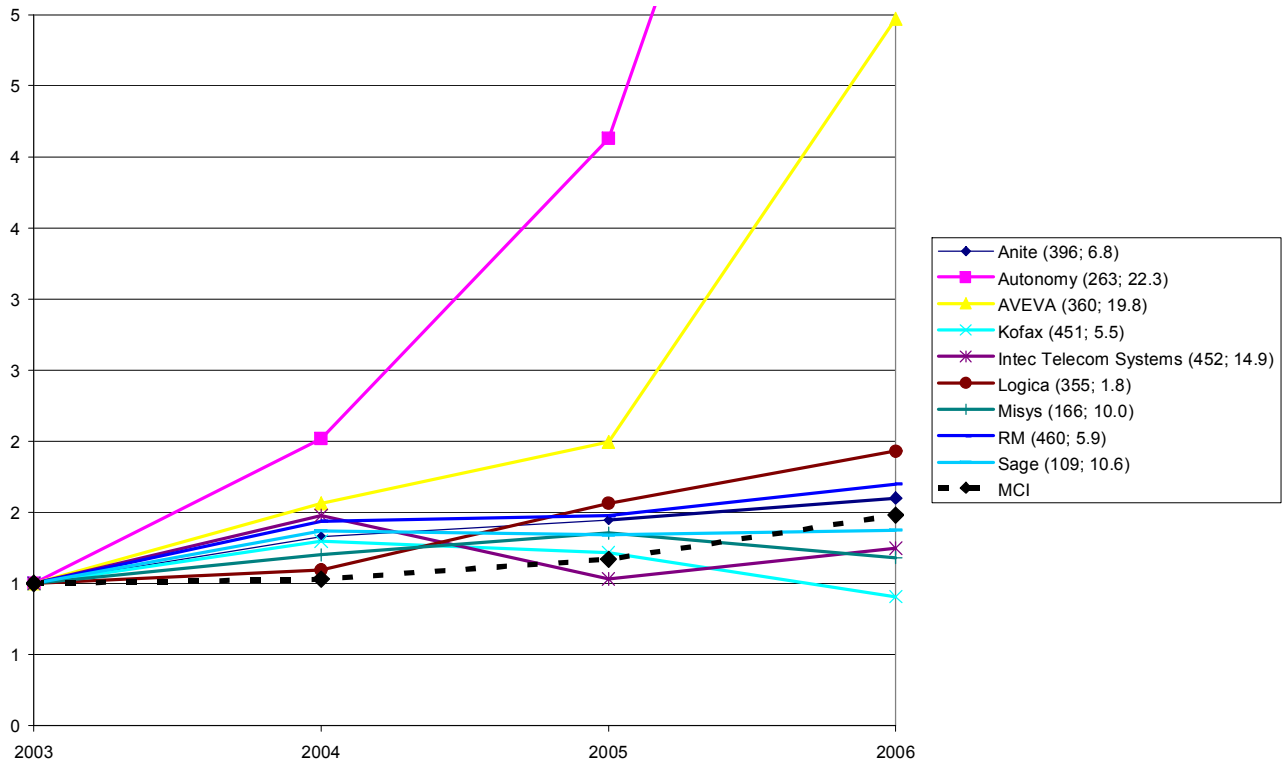
Figure 3. DAX Technology Index - Market capitalisation evolution (2003 = 1)



In terms of market capitalisation, the 10 firms of the R&D portfolio represents in 2006 about 72% of the total value (MCI) of the sector. 6 firms out of the 10 appear to outperform the MCI. Among these firms, we found the largest ones in terms of R&D investment in 2007, Infineon

technologies (this company is ranked in the 24th position among the top 1000 EU companies of the 2008 R&D scoreboard). However the size of R&D investment does not seem to be correlated with the market capitalisation performance. Indeed, Dialog semiconductor which has also a very high performance, is one of the smallest firm in terms of the size of its R&D investment (Rank = 461) while SUESS Microted (rank = 561) and Muhlbauer (rank = 481) are underperforming with respect to the MCI of the sector. In terms of R&D intensity, medium high tech companies seem to outperform the low tech companies as well as the two companies with the highest R&D intensities, Dialog semiconductor and ELMOS semiconductor (average R&D intensities over 2004-2006 of 25.3% and 19.2% respectively). Finally these firms, while exhibiting very high R&D intensities are not among the largest ones in terms of R&D and furthermore they have been created quite recently[20]. These companies could be in an early stage of their development and while investing relatively a lot in R&D could not yet have reached their optimal scale which could be reflected in their share prices and therefore market capitalisation performance.

Figure 4. FTSE Software and computer services Index – market capitalisation evolution (2003 = 1)



[20] Dialog was founded in 1981 and ELMOS in 1984 (source: website of companies).

Figure 4 presents the case of the FTSE all share software and computer services index, where computer services and software companies of the scoreboard and from the UK are operating. The number of firms included in the R&D portfolio corresponding to this sector is 9. Altogether, they represent in 2006 about half of the total MCI of the sector. As compared with the other sectoral stock market indexes, this sector is performing well, albeit somewhat less when the companies with the most extreme performances are removed. Interestingly, in terms of R&D intensity, the two companies with the highest ratios, Autonomy and Aveva (average R&D intensities over 2003-2006 of 22.3% and 19.8% respectively) are also the ones that exhibit the highest market capitalisation performances over the period investigated.

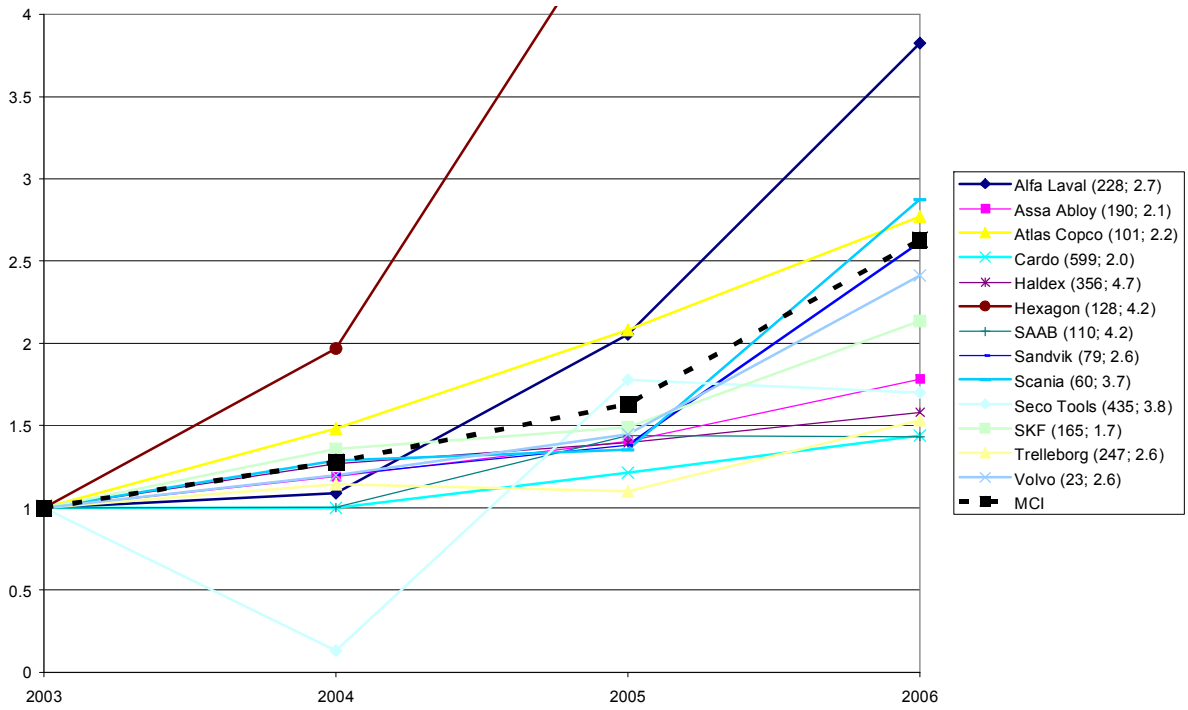
Figure 5 concerns the Stockholm SE capital goods index which corresponds to a quite heterogeneous set of R&D scoreboard sectors, mainly industrial machinery, construction and materials, commercial vehicles and trucks and general industrials. This sectoral stock market index illustrates the case where companies from the R&D portfolio do not outperform nor underperform the ones entering the sectoral index in terms of the evolution of their market capitalisation over the period 2003-2006. The number of companies analysed in the R&D portfolio corresponding to this sectoral index is 13 over the period 2003-2006 while the index itself is comprised of 51 companies. The R&D portfolio in 2006 is representative of about 60% of the sector MCI. As can be seen in tables 2 and A.3.2., the evolution of the MCI of the sector is quite high as compared to the other stock market sectors and this performance is not affected by the presence of outliers although the firms that belong to the motor vehicles subsector, e.g. SAAB and Volvo, are clearly underperforming. Yet, the high heterogeneity characterising this index does not allow one to detect any specific patterns in terms of the relationship between size of R&D investments, R&D intensity and market capitalisation performance.

The last case investigated in this section is the FTSE electronic and electrical equipment sectoral stock market which contains 12 firms in total, 9 of them being also in the corresponding R&D portfolio which represents in 2006, 68% of the total market capitalisation of this sector. This sectoral index exemplifies the case where the R&D portfolio's firms are underperforming as compared to the sector's MCI[21]. In comparison to the other sectoral stock market indexes, this one is performing better in terms of the evolution of its market capitalisation, though to a somewhat lesser extent if we control for the most extreme values. Except for Morgan Crucible, the two firms that invest the most in R&D, i.e. Invensys and

[21] The CAC technology, hardware and equipment index in France is the only other sector in the same situation.

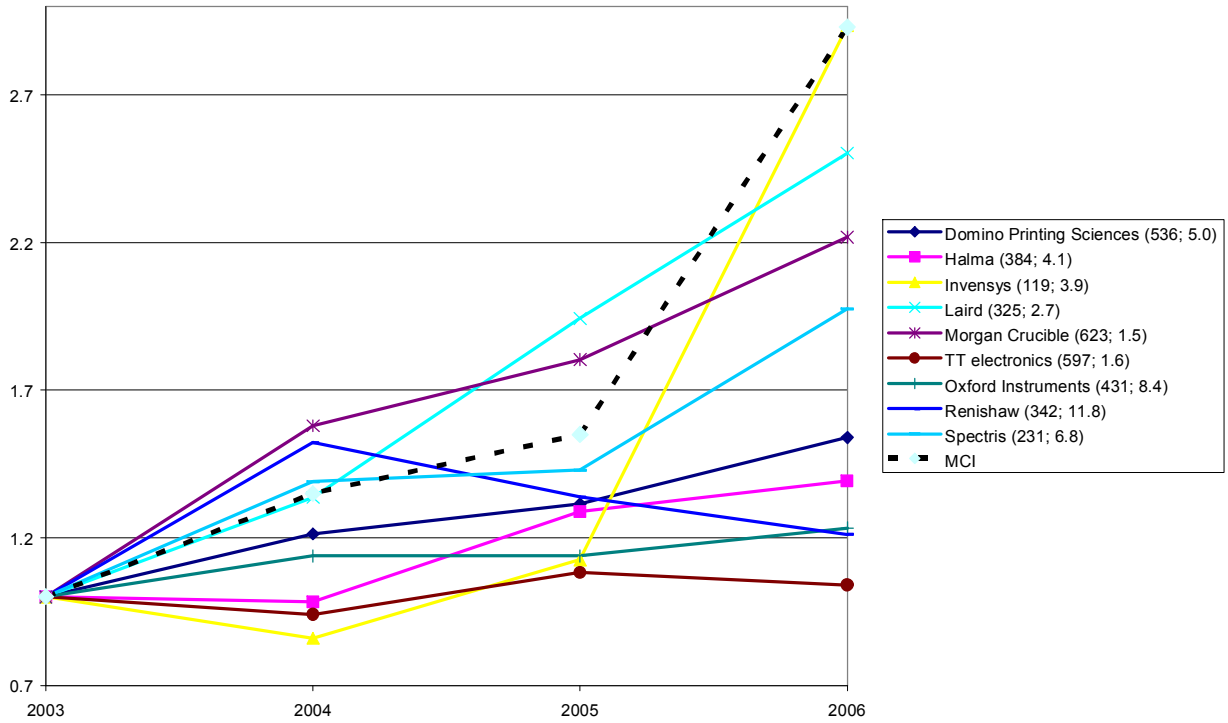
Spectris, are also the two ones characterised by the highest performance in terms of their market capitalisation evolution over the period 2003-2006.

Figure 5. Stockholm SE capital goods Index – Market capitalisation evolution (2003 = 1)



Overall, the results of this section indicate that the relationship between firms R&D investments, R&D intensity and stock market performance is neither systematic nor straightforward. In some stock markets and industry sectors, firms characterized by relative high levels of R&D effort and R&D investments appear to outperform. In other cases, firms that invest less in R&D are doing better. These findings however are based on five selected sectoral stock market indexes and a question that remains to be verified is whether these conclusions remains valid and can be generalised to other firms and sectoral stock markets. In order to attempt to answer and to get a more comprehensive view of this question, the results of an econometric analysis based on the whole data set of 304 companies are reported and discussed in the next section.

Figure 6. FTSE Electronic and electrical equipment Index – market capitalisation evolution (2003 = 1)



4.4. Econometric analysis

In order to further investigate the relationship between firms' market capitalisation performances, the size[22] and intensity of R&D investments, a regression analysis based on the data set of the top 304 largest EU R&D companies from the scoreboard has been performed. The basic specification for the cross sectoral stock market regression is:

$$\Delta MC_{i,2003-2006} = \alpha_0 + \alpha_1\left(R_{i,2004}\right) + \alpha_2\left(RDI_{i,2004}\right) + \alpha_3\left(SIZE_{i,2004}\right) + \sum_{k=2}^{K} SSMD_{i,k}$$

where the dependent variable $\Delta MC_{03\text{-}06}$ is the growth rate of firms' i market capitalisation between 2003 and 2006 and the explanatory variables R_{04} and RDI_{04} indicate its amount of

[22] From a theoretical point of view, small firms may not have all resources to engage in R&D because of the costs and uncertainties associated with these activities (Schumpeter, 1942), as compared to large firms that can better appropriate the returns of their R&D investment. As a result, large R&D investors can be expected to experience higher financial performance than smaller firms in terms of size or R&D effort.

R&D investment and intensity[23]. This equation also includes a binary variable, SIZE, that takes the value one for the 20 largest companies of the sample in terms of R&D in 2004 as well as a set of sectoral stock markets' dummies to control for differences in the stock market performance across sectors.

Table 3. Ordinary last squares results of the cross-sectoral stock markets regression

Constant	2.4540*	2.2185*	2.4340*	2.5057*
	(.3755)	(.2467)	(0.3687)	(0.6037)
R_{2004}	-0.4136***		-0.3878***	0.1880
	(.2335)		(.2264)	(0.3638)
RDI_{2004}		0.1073*	0.1107*	0.1144*
		(.0257)	(.0214)	(0.0215)
SIZE				-1.8870***
				(-1.0760)
Obs.	278	280	276	276
R^2a	0.7472	0.7429	0.7583	0.7628

Notes: Robust standard errors; all regression with sectoral stock market dummies included; *(resp. **, ***) means statistically significant at the 1% (resp. 5, 10%) level. SIZE = 1 for the top 20 largest firms in terms of R&D investments in 2004 (SAP; Infineon Technologies; BASF; STMicroelectronics; Finmeccanica; BAE Systems; Alcatel-Lucent; Renault; Peugeot-PSA; EADS; Ericsson; Bayer; Philips Electronics; BMW; AstraZeneca; Nokia; GlaxoSmithKline; Sanofi-Aventis; Volkswagen and Siemens).

The estimation results are presented in table 3. The firms' R&D intensity appears be to positively correlated to the firms' financial performance while a negative impact is found for the size of R&D investments. When the dummy variable SIZE is introduced in the specification, the coefficient associated with the R&D investments variable is no longer significant while the dummy variable has a negative sign, hence indicating that largest firms in the sample (in terms of the amount of R&D invested) are relatively underperforming the other ones in terms of their market capitalisation performance[24]. Two explanations can be put forward to explain relationship between R&D investments and the stock market performance. On the one hand, top R&D companies in terms of R&D investments in the EU such as GlaxoSmithKline, Nokia or Siemens are well established leaders with quite high and stable stock market performance over time. On the other hand there are plenty of examples of relatively small and recently created firms with successful patented inventions that outperform their rivals in a given sector.

[23] The choice of 2004 for the R&D investments and the R&D intensities has shown to result in the best fits of the estimated coefficients (lowest standard errors) which would indicate a two years lag between the R&D effort and R&D investment of a firm and its financial performance as measured by the growth rate of its market capitalisation.

[24] It should be noted that these findings are robust to the presence of outliers. The estimated coefficients are not altered when the specification is estimated without the below 5th and above 95th percentile observations.

Yet, this last argument has to be further investigated as the 'smallest' firms in terms of R&D investments of the sample used in the present study are by definition large as they are part of the top EU 500 R&D Scoreboard.

5 Summary and concluding remarks

The analysis performed in this paper aimed at deepening the understanding of the link between R&D investment and the performance of companies in the financial markets. This is a central question that still needs to get solid, not only anecdotal, evidence. The answers are of fundamental interest for companies, analysts and policy-makers.

The analysis has been based on a representative portfolio of 304 EU top R&D investing companies over a four year-time period (2003-2006). The dataset gatters information for each company on share prices, market capitalisation, R&D investment and intensity as well as global and sectoral stock market indexes.

Although such data set in which the analysis has been based is original for the number of companies, for the variables collected, and for the geographical coverage, the data present some limitations such as for instance the impossibility to match the sectoral classifications across sectors, countries and time-period of the R&D portfolios with the sectoral stock market indexes.

Yet, the overall analysis, except in a few cases, gives some robust evidence of a positive relationship between top R&D-investing companies and their performance in the stock markets. Furthermore, the empirical findings from the econometric analysis suggest a linear relationship between firms' market capitalisation performance and R&D intensities. The relationship between firms' market capitalisation performance and R&D intensities is less straightforward. The largest companies in terms of R&D investments are characterised by a positive and stable growth rate of their market capitalization over time but some relatively 'smaller' firms appear to perform better. While more data and investigation are probably needed to better uncover this relationship, two hypothesis which are not necessarily mutually exclusive, can be put forward to explain this relationship. On the one hand, results obtained do not contradict Schumpeter's idea of creative destruction which states that large and established corporations in a given market can see their profits fall and their dominance vanish as smaller and rivals successfully launch new and improved products or cut manufacturing costs thanks to new processes. On the other hand, some smaller companies in

terms of R&D investments that operate in some high R&D intensive sectors (typically, biotech and software) appear to perform better than larger R&D investors because of their higher potential (both in economic and financial terms), which translates into higher expectations in terms of gains in the stock market.

Among the most telling results from this study that can be highlighted, we can mention the outperforming behaviour of top R&D investing companies from the pharmaceuticals and biotechnology and software & computer services sectors in the UK (between 7.4 and 35.8% more from the beginning of the period to the end) and the chemicals sector in Germany (25.7 % more). It also concerns the overall outperforming behaviour of top R&D investing companies listed in the German and Danish stock market exchanges in all the sectors analysed (38.5 and 27.1% respectively). On the other hand some other sectors, such as the technology hardware and equipment one in France, are underperforming.

Therefore, and besides the limitations of the data, we should acknowledge that R&D represents an important strategic element for companies' performance, but is not the only one. There are other relevant factors both within and outside the firms' boundaries that have an impact on companies' performance. Accordingly, the appreciation of investors in the stock markets reflects these considerations.

Further investigation is needed in this domain. For example, relying on more homogeneous and representative samples of both R&D and non-R&D investing companies would allow one addressing some of the main data limitation. In addition, a more direct investigation of the relationship between R&D and stock market performances by controlling for other determinants would enrich the analysis and help to shed more light on the impact of firms R&D activities on their financial results. Another interesting aspect would be to carefully examine the timing of R&D investment and its impact in the stock market. Moreover, in studying the relationship between firm's stock market value and R&D investment it would also be interesting to look at indicators on the output side of R&D activities, such as patents and/or company' goods and services with high technology/innovation content.

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Annex I: Data

A1.1. IDENTIFICATION OF THE COMPANY SET

As a starting point, the top 500 EU companies from the *2008 and 2007 European Commission Industrial R&D Investment Scoreboard* were used in the paper. If any company has de-listed since the final 2008 dataset was delivered and the share data has been collected (e.g. Clarins, France and Alliance & Leicester, UK) they have been replaced by the next highest ranked listed companies i.e. if two companies in the top 500 have de-listed the listed companies ranked 501 and 502 have been included.

A1.2. IDENTIFICATION OF DATA TO BE CAPTURED

A1.2.1. Identification of the companies' most liquid equity and the main Stock Exchange that this is traded on.

For each company *Reuters 3000 Xtra* has been used to identify simultaneously the most liquid equity[25] for that company and the main Stock Exchange that this is traded on. For example TCFP.PA is the most liquid equity for Thales SA and the main Stock Exchange on which it is traded is Euronext Paris.

Where a company has Class A and Class B shares the most liquid of the two has been used. An example of this is Volvo, where the more liquid Class A shares have been used.[26]

For most companies the main Stock Exchange is the same country to which the company is allocated in the Scoreboard. For some companies, however, this is not the case. EADS is allocated to The Netherlands in the Scoreboard but its main Stock Exchange is in France (Euronext Paris).

For dual-listed companies (e.g. Unilever PLC, which is listed on the London Stock Exchange and Unilever NV, which is listed on Euronext Amsterdam) the equity chosen is that which is traded on the Stock Exchange that corresponds to the country to which the company is allocated in the Scoreboard. For Unilever, this is the London Stock Exchange.

Under this heading, our data capture process is subject to a double-blind verification procedure.

A1.2.2. Identification of the main Stock Market Index and the relevant Sector Index of the primary Stock Exchange on which the companies' most liquid equity instrument is traded.

For each company, we have again used *Reuters 3000 Xtra* to identify simultaneously the main Stock Market Index and relevant Sector Index of the Stock Exchange on which the company's most liquid equity is traded. For example, in the case of Thales SA, the main Stock Market Index is the CAC All Share Index and the relevant Sector Index is the CAC Aerospace & Defence Financial Index.

The main Stock Market Index has been taken to be the relevant “All Share” or “Composite” index of the company's primary Stock Exchange. The reason for this is that it gives the fullest dataset of companies traded in the relevant stock market.

[25] See the glossary in the Appendix A1.6 for a definition of “most liquid equity”.
[26] See the glossary in the Appendix A1.6 for a definition of “Class A and Class B shares”.

A1.3. SHARE PRICE & MARKET INDEX VALUE DATA CAPTURE PROCESS

A1.3.1. Entry of data from identification phase above into Company Reporting Database

Once each Stock Market and Sector Index that is being used in the study is identified the information is entered into the database. After this step each company is tagged with its relevant Stock Market and Sector Index.

A1.3.2. Capture, entry and verification of Company Share Price, Market Index values and Sector Index values

For each company we have interrogated *Reuters 3000 Xtra* for company share price, market index and sector index data. This data has then been saved in spreadsheet form.

Once we have the data in spreadsheet form it is prepared for data entry. This same process is repeated and subject to the double blind verification. One person to enter data into the database using spreadsheets prepared for data entry - another person to verify data using spreadsheets prepared for data verification.

A1.4. ANNUAL ACCOUNTS DATA CAPTURE PROCESS

The first four years of historical financial data, i.e. 2004–2007, used in the analysis is the same data as used in the *2008 European Commission Industrial R&D Investment Scoreboard.* Any company for we did not have a full eight year history of financial data, the appropriate annual accounts were sourced to give the most complete financial data set.

Where annual accounts could not be obtained to give a full eight year history, comparative figures was taken from the earliest set of annual accounts to give the most complete dataset possible.

The most complete dataset of financial and share data is used for each company. For example, six years of financial data was captured for Burelle, however eight years of share data was captured.

All financial data captured is entered into the database, which is then verified using the double blind verification procedure.

A1.5. CURRENCY

All currency amounts are displayed in Euro's. Any currency amounts not captured in Euro's have been translated at the Euro exchange rate ruling at 31 December 2007. This also applies to the historical comparative data. The rates used are:

Czech Republic: 26.59 Koruna

Denmark: 7.46 Danish Kronor

Hungary: 252.80 Forint

Poland: 3.60 Zloty

Slovenia: 261.25 Tolar

Sweden: 9.45 Swedish Kronor

UK: £0.73

A1.6. GLOSSARY

Share Price –The price of a single share of a company's stock as listed on its main stock exchange.

Most liquid equity – Term used to describe a company's share which is most frequently traded.

Class A & Class B shares – The differences in shares can be voting rights and dividend entitlement. The differences between the two shares differ from company to company with no set standard on what each class of share is.

Share portfolio value – The "Share Portfolio Value" has been constructed using the sum of the value of each share in the portfolio based on its share price. That is, the portfolio is made up of one share from each company.

Market capitalisation portfolio value – The "Market capitalisation Portfolio Value" has been constructed using the sum of the value of market capitalization from each company in the portfolio.

Main Stock Exchange – Where the company first issued shares, therefore holds the greatest numbers of shares and is the most liquid market.

A1.7. DATA REPRESENTATIVENESS

Table A1.1. Representativeness of R&D investments
304 firms dataset with respect to R&D 1000 EU top firms scoreboards (in %)

Country	2004	2005	2006	2007
Austria	33	32	32	37
Belgium	82	83	78	75
Denmark	68	72	74	73
Finland	87	93	86	89
France	93	87	86	88
Germany	62	60	70	59
Hungary	94	94	94	94
Ireland	74	77	75	68
Italy	44	50	49	49
Slovenia	88	89	92	93
Spain	69	70	67	60
Sweden	90	91	91	89
The Netherlands	91	82	85	79
UK	93	92	85	77
Total	77	76	78	72

A1.8. DATA LIMITATIONS

- All figures are nominal and expressed in euros with all foreign currencies having been converted at the exchange rate prevailing on 31 December 2007. Financial indicators consolidated from companies' activities in different currency areas are influenced by fluctuations in exchange rates.
- Share prices for each company and sector index values and stock market index values were the closing prices and values as at the last trading day of the year, i.e. 31 December 2007 back to 29 December 2000. Market capitalisation values at the company level are at the close of trading on 24 August of each year of the 2003-2007 period. To improve the comparability of data, the same date should be chosen for all figures. Figures averaged over a full calendar year could also be considered to avoid any particular event that could affect the share price and market capitalisation values at any given date.
- The composition in terms of the firms listed in stock markets and sectoral indexes are changing over time and across stock markets. With that respect an outlier could be identified, i.e. a huge increase in the market capitalisation of the RIME Xetra Industrial Index caused by Quarterly review of this Index changes. Generally the German Stock exchange makes Index changes every quarter for all the German indexes. In 2003 the first quarter index changes happened with effective date 24/03/2003 for all the German indexes. As a result of this review the constituents (i.e. number of companies) for the mentioned Index increased from 38 on 21/03/2003 to 68 on 24/03/2003.
- Share prices vs. market capitalisation

  The number of shares issued by each company is arbitrary. This affects the relative weighting in the calculation of the year on year changes in the “Share Portfolio Value”. The movement in the share price of a company which has issued a small number of shares will have a greater impact on the portfolio value than a company which has issued a large number of shares. For example MTU Aero Engines with a share price of 40 Euro’s will have a greater impact on the portfolio value than EADS with a share price of 21.83 Euro’s. By constructing a market cap for each company, EADS with 17.79bn Euro’s (815m x 21.83 Euro’s) and MTU Aero Engines with 2.04bn (51m x 40 Euro’s) we can see MTU Aero Engines is represented by something twice the size of EADS but on the basis of market capitalisation it would be represented by something one ninth the size of EADS. So the two representations differ by a factor of 18. Each has its advantages, but they represent different views.

  Note that for share prices, corporate actions, e.g. stock splits/reverse stock splits (stock consolidation) relating to the portfolio can affect the outcomes. For example, a company undergoes a stock split 1:2 and as a result price changes from 1 Euro per share to 0.50 Euro per share, although no real value change occurred (the only difference is that the company had 100 shares now it has 200 shares). It this case the portfolio should be adjusted accordingly and not treat this as a drop in share price.
- Not all companies have a full eight year share price history as they may not have been listed companies for the full time series. Where this is the case, as much share price data as possible is used. For example, Q-Cells has only three years of share price data and is included in the database.
- Not all Sector Indexes have a full eight year history of values. For example, on Euronext Brussels, there is only a 3 year time series of data.
- Stock exchanges throughout Europe do not use the same Industry Classification System when preparing Sector Indexes. For example, the London Stock Exchange and the

Euronext Exchanges (Amsterdam, Brussels, Lisbon and Paris) use the ICB classification system. The OMX Nordic Exchanges (Copenhagen, Helsinki and Stockholm) use the GICS classification system. The Frankfurt Stock exchange uses its own Industry Classification System developed by Deutsche Borse. Although some important economic sectors are represented in all Industry Classification Schemes (e.g. Pharma & Biotech), there are subtle differences in the composition and definition of many of the sectors under each different Industry Classification System. For example, the ICB system has Oil & Gas as a separate sector while the Deutsche Borse system includes Oil & Gas companies in the Basic Resources Sector. This renders problematic the standardisation of all the different Industry Classification Systems (i.e. transforming them all to ICB) and may limit the opportunity for "cross-exchange" comparisons at Sector level.

- Not all stock exchanges allocate companies at the same "level" within their chosen Industry Classification System. For example, the London Stock Exchange and the Euronext Exchanges (Amsterdam, Brussels, Lisbon and Paris) use the ICB classification system and the Sector Indexes are at ICB 3-digit level – consistent with the Scoreboard classification. However, the OMX Nordic Exchanges (Copenhagen, Helsinki and Stockholm) use the GICS classification system and the Sector Indexes are at the ICB equivalent of 2-digit level – one level up from the Scoreboard classification.
- Each Stock Exchange provides only a partial set of Sector Indexes at "Sector" level. For example, on Euronext Brussels, there is no Electronic & Electrical Equipment or Retail Sector Index. The Indexes provided are at ICB 1-digit level (Industrials and Consumer Services, respectively), rather than at ICB 3-digit level. Although the vast majority of Sector Indexes are prepared at the same level within any given Industry Classification System, when they are prepared at more than one level this may limit the opportunity for "cross-sector" comparisons.
- Stock Exchanges with a relatively small number of listed companies do not provide Sector Indexes. Stock Exchanges of companies included in the database that do not have a sector index are Vienna, Prague, Budapest, Ireland & Slovenia. It is presumed that, as these are smaller stock exchanges with fewer companies listed on them, the creation of Sector Indexes would not be meaningful.
- Not all companies are included in a market and/or sector index. An example is Autoliv, Sweden, which is not included in a market or sector.
- Some stock markets do not provide share prices sectoral indexes based on the ICB nomenclature. In that case, alternative stock markets where firms are listed and that provide the ICB classification could be considered. This will be possible when the retained stock market provides the same level of disaggregation of the ICB classification.

Annex II: Stock market and Sectoral market capitalisation

Table A2.1. Evolution of stock market and sectoral market capitalisation based indexes (benchmark = 1 for first available year)

	2001	2002	2003	2004	2005	2006	2007
DAX COMPOSITE	1	0.64	1.10	1.13	1.19	1.62	2.06
PRIME_XETRA_AUTOMOBILE	1	0.82	1.13	1.15	1.30	1.69	2.57
PRIME_XETRA_CHEMICALS	1	0.86	1.29	1.55	1.85	2.36	3.71
PRIME_XETRA_PHARMA_HEALTHCARE	1	0.88	0.55	0.66	0.78	1.36	0.82
PRIME_XETRA_TECHNOLOGY	1	0.59	0.19	0.16	0.13	0.18	0.18
				2004	2005	2006	2007
DAX COMPOSITE				1	1.05	1.44	1.82
PRIME_XETRA_AUTOMOBILE				1	1.13	1.47	2.23
PRIME_XETRA_CHEMICALS				1	1.19	1.52	2.40
PRIME_XETRA_PHARMA_HEALTHCARE				1	1.18	2.05	1.24
PRIME_XETRA_TECHNOLOGY				1	0.79	1.16	1.12
				2004	2005	2006	2007
FTSE ALL SHARE				1	1.09	1.36	1.36
FTSE_ALL_SHARE_ELECTRONIC_ELECT				1	1.15	2.17	2.02
FTSE_ALL_SHARE_PHARMA_BIOTECH				1	1.13	1.17	1.03
FTSE_ALL_SHARE_SOFTWARE_COMPUTER_SERVICES				1	1.14	1.44	1.33
FTSE_ALL_SHARE_TECHNOLOGY_HARDWARE				1	0.98	0.85	0.84
				2004	2005	2006	2007
OMX COPENHAGEN				1	1.15	1.51	1.74
OMX_COPENHAGEN_PHARMA_BIOTECH				1	0.96	1.51	1.95
				2004	2005	2006	2007
OMX_STOCKHOLM				1	1.13	1.59	1.86
OMX_STOCKHOLM_CAPITAL_GOODS				1	1.27	2.06	2.52

Annex III: Robustness Checks

Table A3.1. Stock market indexes vs. R&D portfolio's firms' performance by market capitalisation (2003 = 1) - Robustness checks.

Stock Market Index	2003	2004	2005	2006
AEX All Share				
MCP-index	1	1.31	1.44	1.73
MCP-index less .05 and .95 centiles	1	1.30	1.43	1.73
UW-MCP -Index	1	1.44	1.63	2.01
UW-MCP -Index less .05 and .95 centiles	1	1.32	1.46	1.85
Brussels SE Cash Market Return				
MCP-index	1	1.55	1.80	2.34
MCP-index less .05 and .95 centiles	1	1.58	1.87	2.46
UW-MCP -Index	1	1.33	1.56	2.15
UW-MCP -Index less .05 and .95 centiles	1	1.36	1.58	2.02
CAC All Share				
MCP-index	1	1.43	1.46	1.72
MCP-index less .05 and .95 centiles	1	1.44	1.46	1.71
UW-MCP -Index	1	1.66	2.02	3.37
UW-MCP -Index less .05 and .95 centiles	1	1.49	1.62	2.51
DAX Composite				
MCP-index	1	1.39	1.54	2.05
MCP-index less .05 and .95 centiles	1	1.41	1.5	2.04
UW-MCP -Index	1	1.49	1.89	2.56
UW-MCP -Index less .05 and .95 centiles	1	1.49	1.73	2.38
FTSE Techmark All Share				
MCP-index	1	1.26	1.36	1.60
MCP-index less .05 and .95 centiles	1	1.20	1.25	1.41
UW-MCP -Index	1	1.27	1.53	2.08
UW-MCP -Index less .05 and .95 centiles	1	1.27	1.45	1.87
Madrid SE General				
MCP-index	1	1.29	1.26	1.71
MCP-index less .05 and .95 centiles	1	0.91	0.90	1.25
UW-MCP -Index	1	1.34	1.65	2.54
UW-MCP -Index less .05 and .95 centiles	1	1.20	1.37	2.06
MIBTEL General				
MCP-index	1	1.36	1.38	1.50
MCP-index less .05 and .95 centiles	1	1.09	1.09	1.20
UW-MCP -Index	1	1.62	1.84	2.86
UW-MCP -Index less .05 and .95 centiles	1	1.68	1.85	2.47
OMX Copenhagen_PI				
MCP-index	1	1.24	1.66	2.38
MCP-index less .05 and .95 centiles	1	1.07	1.49	2.23
UW-MCP -Index	1	1.47	2.36	3.39
UW-MCP -Index less .05 and .95 centiles	1	1.56	2.44	3.61
OMX Helsinki_PI				
MCP-index	1	1.37	1.59	2.12
MCP-index less .05 and .95 centiles	1	1.34	1.54	2.04
UW-MCP -Index	1	1.39	1.78	2.35
UW-MCP -Index less .05 and .95 centiles	1	1.34	1.73	2.20
OMX Stockholm_PI				
MCP-index	1	1.26	1.38	2.03
MCP-index less .05 and .95 centiles	1	1.24	1.32	1.96
UW-MCP -Index	1	1.44	2.16	3.10
UW-MCP -Index less .05 and .95 centiles	1	1.44	1.90	2.91
Wiener Boerse				
MCP-index	1	1.92	2.42	2.80
MCP-index less .05 and .95 centiles	1	1.71	2.05	2.01
UW-MCP -Index	1	1.80	2.49	3.55
UW-MCP -Index less .05 and .95 centiles	1	2.05	2.77	3.24

Notes:

- MCP = market capitalisation (sum) of R&D portfolio's companies;
- UW-MCP = unweighted MCP (average values of firm's MCP normalised to one at the beginning of the period).

Table A3.2. Sector indexes vs. R&D portfolio's firms performance by market capitalisation (2003 = 1) - Robustness checks.

Stock Market	2003	2004	2005	2006
CAC Technology Hardware & Equipment				
MCP-index	1	1.05	1.00	1.36
MCP-index less .05 and .95 centiles	1	1.16	1.14	1.74
UW-MCP -Index	1	1.90	1.73	3.07
UW-MCP -Index less .05 and .95 centiles	1	1.64	1.57	2.56
FTSE All Share Electronic & Electrical Equipment				
MCP-index	1	1.18	1.38	2.19
MCP-index less .05 and .95 centiles	1	1.31	1.42	1.80
UW-MCP -Index	1	1.22	1.38	1.94
UW-MCP -Index less .05 and .95 centiles	1	1.30	1.39	1.74
FTSE All Share Pharmaceuticals & Biotechnology Index				
MCP-index	1	1.11	1.26	1.16
MCP-index less .05 and .95 centiles	1	1.11	1.26	1.16
UW-MCP -Index	1	1.29	1.52	1.86
UW-MCP -Index less .05 and .95 centiles	1	1.20	1.58	1.75
FTSE All Share Software & Computer Services Index				
MCP-index	1	1.30	1.50	2.01
MCP-index less .05 and .95 centiles	1	1.28	1.41	1.71
UW-MCP -Index	1	1.42	1.73	3.01
UW-MCP -Index less .05 and .95 centiles	1	1.35	1.46	2.18
FTSE All Share Technology Hardware & Equipment Index				
MCP-index	1	1.28	1.25	1.55
MCP-index less .05 and .95 centiles	1	1.33	1.34	1.60
UW-MCP -Index	1	1.17	1.23	1.46
UW-MCP -Index less .05 and .95 centiles	1	1.24	1.42	1.37
PRIME Xetra Chemicals Index				
MCP-index	1	1.47	1.61	2.30
MCP-index less .05 and .95 centiles	1	1.51	1.67	2.52
UW-MCP -Index	1	1.55	1.83	3.00
UW-MCP -Index less .05 and .95 centiles	1	1.66	1.94	3.09
PRIME Xetra Industrial Index				
MCP-index	1	1.26	1.38	2.10
MCP-index less .05 and .95 centiles	1	1.25	1.33	1.99
UW-MCP -Index	1	1.37	1.68	2.33
UW-MCP -Index less .05 and .95 centiles	1	1.41	1.73	2.34
PRIME Xetra Pharma+Healthcare Index				
MCP-index	1	0.94	2.75	2.74
MCP-index less .05 and .95 centiles	1	1.62	3.93	2.75
UW-MCP -Index	1	1.52	2.65	2.70
UW-MCP -Index less .05 and .95 centiles	1	1.35	2.32	2.30
PRIME Xetra Technology Index				
MCP-index	1	1.00	1.01	1.36
MCP-index less .05 and .95 centiles	1	0.98	0.99	1.33
UW-MCP -Index	1	1.16	1.03	1.36
UW-MCP -Index less .05 and .95 centiles	1	1.11	0.98	1.26
Stockholm SE Capital Goods				
MCP-index	1	1.24	1.56	2.64
MCP-index less .05 and .95 centiles	1	1.26	1.56	2.66
UW-MCP -Index	1	1.18	1.76	2.82
UW-MCP -Index less .05 and .95 centiles	1	1.29	1.81	3.03

Notes:
MCP = market capitalisation (sum) of R&D portfolio's companies;
UW-MCP = unweighted MCP (average values of firm's MCP normalised to one at the beginning of the period).

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Title: The Performance of Top R&D Investing Companies in the Stock Market

Authors: Michele Cincera, Raquel Ortega-Argilés, Pietro Moncada Paternò Castello (European Commission, JRC-IPTS)

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Technical Note

Abstract

Based on an original data set with information of a representative portfolio of among the largest 304 R&D investing companies over the 2003-2006 period, the overall analysis, except in a few cases, gives some robust evidence of a positive relationship between top R&D-investing companies and their performance in the stock markets as measured by the evolution of their market capitalisations' values. In terms of sectors, companies in the pharmaceuticals and biotechnology and software & computer services sectors in the UK and the chemicals sector in Germany appear to outperform the respective sectoral stock market indexes in which they operate. On the other hand some other sectors, such as technology hardware and equipment one in France, show an underperforming behaviour.
Empirical findings from the econometric analysis suggest a positive impact of the firm's R&D intensity on its market capitalisation performance.
Besides some data limitations which call for further investigations, R&D investment can without uncertainty be acknowledged as representing an important strategic element for companies' economic and financial performance, but is not the only one. To name a few of them, framework conditions in the economy, marketing activities and the level of market power of companies are only other important factors that have an impact on companies' performances which are also reflected on their stock markets values.

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