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Capital markets reward R&D

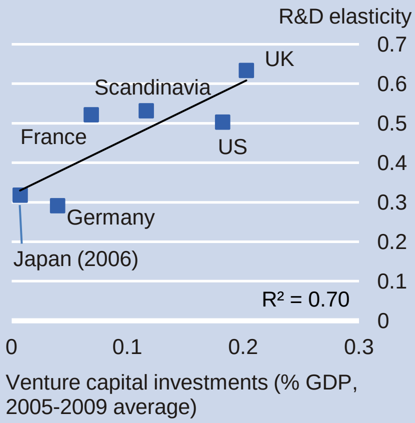
Companies with an R&D intensity 50% higher than their industry average boast a 14-21% higher market capitalisation. This is a key finding of a detailed analysis of more than 1,000 research oriented companies worldwide over the period between 2002 and 2009. It shows how handsomely investors reward long-term investments in research and development (R&D) as a source of new growth options.

High R&D elasticities speed up technological progress. A positive relationship between R&D intensity and market capitalisation (R&D elasticity) is a direct incentive to invest in R&D. It also promotes the culture of entrepreneurship, since innovative start-ups achieve higher prices when they are subsequently listed on the stock market. As a result, R&D elasticity also influences the industry structure by favouring the development of research-intensive sectors.

R&D elasticity is highest in Anglo-American countries – and lowest in Germany and Japan. It is arguably no coincidence that the US and the UK are the very countries with the highest overall investments in the venture capital segment and fastest productivity growth. Their above-average number of companies in modern research-intensive sectors such as biotechnology, pharmaceuticals or software also illustrates the impact of high R&D elasticity.

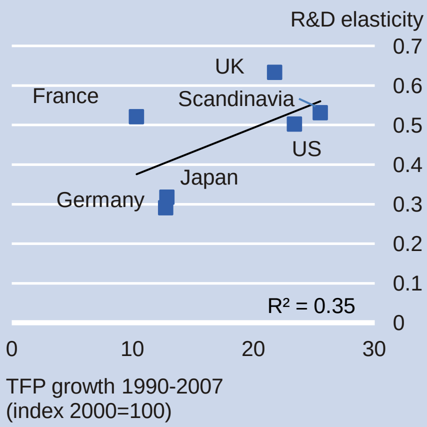
Modern financial systems are catalysts for research and development. Investors are particularly required not only to assess the volume of the R&D budgets but also their quality, strategy and conversion into novel, successful products. For policymakers the relationship measured here is an important signal that innovations in the real economy do also require highly developed capital markets.

High elasticity rewards innovative founders



Sources: DB Research, JRC, OECD, PwC, 2011

Productivity thrives



Sources: AMECO, DB Research, JRC, 2011

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Authors
Thomas Meyer
+49 69 910-46830
thomas-d.meyer@db.com

Philipp Ehmer

Editor
Antje Stobbe

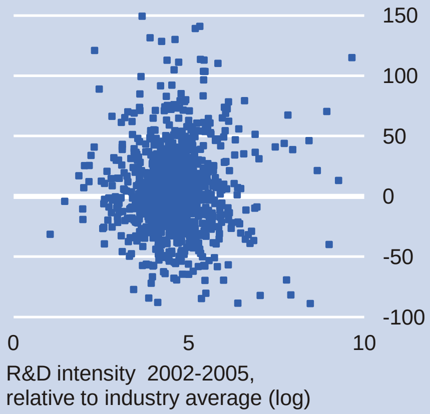
Technical Assistant
Angelika Greiner

Deutsche Bank Research
Frankfurt am Main
Germany
Internet: www.dbresearch.com
E-mail: marketing.dbr@db.com
Fax: +49 69 910-31877

Managing Director
Thomas Mayer

Source: Booz & Company, 2005[2]

Do you see the pattern?



Sources: DB Research, JRC, 2011 1

Global spending on research and development (R&D) will total nearly EUR 1,000 bn this year. Depending on the country, business accounts for between 50% and 80% of total investment in R&D. Companies are often the driving force, particularly in the case of application-oriented and potentially lucrative innovations. The incentive to spend on R&D depends on how willing investors and customers are to reward innovations. The relationship between R&D and business success thus has a major influence on the pace of technological progress.

The aim of this report is to determine the impact of R&D investments on a variety of business success metrics. Although plausible, this relationship is not apparent at first glance (see chart 1) and is a highly contentious issue in the literature.[1] Our analysis shows, however, that research-intensive companies have much higher market capitalisations than their competitors who conduct less research. This finding is relevant for investors because it confirms that large R&D budgets – other things being equal – justify a premium.

The basis of this study is an analysis of more than 1,000 research oriented companies worldwide. The analysis also allows us to show how the effect differs depending on the industry and the region. We find the strongest correlation between R&D investment and market capitalisation (the R&D elasticity) in the Anglo-American countries and in Scandinavia.

Overall, the R&D elasticity proves to have major macroeconomic significance: countries with high R&D elasticity also experience much faster technological progress with corresponding productivity gains. The good figures for the US and the UK also suggest that modern highly developed stock markets are a key factor in generating innovative capacity since R&D is more heavily influenced by equity capital than other types of investment. Innovation policy is thus also capital market policy.

High elasticity is also an incentive to invest in fledgling technology firms as they attain higher prices when they are subsequently floated (IPO). The consequences are larger investments by venture capital funds and stronger start-up activity in the high-tech segment.

For the first time we also investigate the ramifications of the financial and economic crisis. We document how the crisis has impacted on R&D elasticity and how companies have reacted to their reassessment. From a scientific point of view the crisis therefore constitutes a type of natural experiment, since it illustrates how investors and companies behave following a major exogenous shock. It is especially in countries where the capital markets have become more sceptical concerning R&D that companies have cut back their R&D spending more sharply. This suggests that the capital market sends clear signals to the companies, which factor them into their investment planning accordingly.

[1] Although it is difficult to see, in chart 1 there is indeed a positive correlation between R&D intensity and future sales growth, statistically significant at the 1% level.

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Research: The status quo

The significance of innovations for corporate success is a regular subject of academic enquiry. An important share of the literature adopts the approach used by Griliches (1981), in which enterprise value is described as the sum of tangible assets and intangible or technological capital. Typical indicators of intangible capital are expenditure on R&D and patents. Based on a sample of 157 US firms for the period 1968 to 1974 Griliches estimates that one additional dollar spent on R&D boosts a company's market value by 2 dollars over the long term. He estimates the value of an additional patent at around USD 200,000.

Later reports have refined the methodology and extended it to other regions. In a meta-study Ballardini et al. (2005) counted 28 analyses that adopted this approach. One advantage of these models is that the results can be interpreted intuitively. The coefficient measured shows what effect a rise in technological capital has on the enterprise value. If this figure is higher than 1, investments in innovations generate a disproportionately strong increase in enterprise value (which would suggest the current investment level is too low). If the value is smaller than 1, the enterprise value increases by only a disproportionately small amount, which would indicate that overinvestment is occurring.

Although a large proportion of the literature confirms the positive contribution of research to enterprise value there are considerable variations between the findings on the scale of the influence as well as its regional and industry-specific differences. Hall and Oriani (2006) for example analysed a sample of 2,156 companies from the manufacturing sector in the US and Europe for the period 1989 to 1998. They identified positive but low coefficients for R&D capital of between 0.3 in France and Germany and up to 0.8 in the UK. These figures suggest overinvestment in R&D.

Duqi and Torlucci (2010) analysed a sample totalling 416 European firms over the years 2001 to 2007. They found that R&D had a disproportionately large influence on market value in the UK, Germany, France and Sweden, as well as a negative effect in Italy. The influence is much stronger than in Hall and Oriani (2006). Also, there are differences in the regional patterns: while Hall and Oriani measure the biggest impact in the UK and the smallest in Germany and France (depending on the model specification), the order in Duqi and Torlucci (2010) is the exact opposite: Germany has the strongest; the UK has the weakest. Both studies share a sceptical assessment of Italy: Duqi and Torlucci identify a negative influence or none at all; Hall and Oriani also find no statistically significant coefficients.

Not a licence to print money

Ballardini et al. (2005) calculated an average coefficient for R&D capital of 0.96 in their meta-study. This suggests that R&D has a robust, positive influence on market valuation. However, the coefficient is close to the theoretical optimum of 1, i.e. investment in R&D generates as much enterprise value as it costs in the first place.

A similar conclusion is made by Chan et al. (2001), who analysed the effect of R&D intensity on the stock market performance of US firms. They found no statistically significant difference in the stock yield, i.e. research-intensive companies generated returns that were on average the same size as those of companies that conducted little research. This does not mean that R&D is carried out in vain but only that different business models with different R&D approaches may ultimately produce similar returns. A different finding would not, however, be compatible with the concept of efficient financial markets: otherwise it would be all too easy to generate excess returns.

Jaruzelski et al. (2005) share a more sceptical view on the role of R&D. They find no statistical relationship between R&D intensity and a series of corporate performance indicators such as sales growth, profits, market capitalisation or yield. Rather than the size of the R&D budget it is the quality of the innovation process that counts, argue the authors of the study which was published by the management consultants Booz Allen Hamilton.

Innovation is a long-term process

Research programmes as a rule do not deliver short-term successes, but are mostly elements of a permanent innovation process that slowly bears fruit. This gives rise to other observations:

- **R&D expenditures are path-dependent:** companies typically invest in a continuous innovation and renewal process. The persistence of the research strength is also shown in our analysis (see table 13 on page 9).
- **Research is an option on future profits:** Bloom and Van Reenen (2002), for example, show that new patents directly increase enterprise value (by the option value of the patent), whereas productivity only increases after a time lag (when the innovation actually reveals its impact).
- **Profits have a positive impact on research:** generously equipped R&D departments can only be maintained if companies are successful. That is why profits have a positive feedback on R&D.
- **The closer a company is to the cutting edge of technology, the greater the importance of research:** for technologically advanced companies in particular R&D provides an escape route from competition, which is why research is more important for innovative industries and business models.

Literature

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Sample: 1,209 companies from 45 sectors and 39 countries

This study analyses the 1,209 companies that spend most on R&D (in terms of absolute R&D budget size) over the period 2002 to 2009. The data is drawn from the R&D Scoreboards 2006 to 2010 of the Joint Research Centre of the European Commission (JRC).[3] The R&D Scoreboards document the key company metrics for the 1,000 biggest corporate R&D spenders inside and outside the EU respectively in two separate lists – thus for a total of 2,000 companies. The composition of the scoreboard does of course change over time: new companies are added, while others disappear. This means there is no simple method for comparing the data over time.

This study therefore distils a sample from the scoreboards which combines the EU and non-EU Top 1,000 lists. It only takes into account companies that were in one of the two Top 1,000 lists at both the beginning and the end of the survey period. This reduces the number of companies to 1,209.

In 2009 the companies in this sample invested a total of EUR 320 bn in R&D. The biggest R&D spender was the Japanese automaker Toyota, which invested EUR 6.8 bn, followed by the Swiss pharma group Roche (EUR 6.4 bn) and the US software company Microsoft (EUR 6.1 bn). The minimum amount that companies have to invest in R&D to make it onto the list is nearly EUR 4.5 m. The mean R&D budget in the sample is EUR 307 m, while the median is EUR 72 m. This shows that the distribution is skewed by a few particularly large companies.

The top 10

EUR bn (2009)

	Sales	R&D budget
Toyota	208.6	6.8
Roche	30.8	6.4
Microsoft	42.0	6.1
Volkswagen	113.8	5.8
Pfizer	34.7	5.4
Novartis	29.8	5.2
Nokia	50.7	5.0
Johnson & Johnson	45.9	4.9
Sanofi-Aventis	27.6	4.6
Samsung Electronics	56.3	4.5

Sources: DB Research, JRC, 2011 2

Key figures from the sample

EUR bn

	2009	2005
R&D investment	320	286
R&D intensity (%)	3.7	3.4
Employees	30,346,008	27,767,500
Sales	8.604	8.344
Profits	738	997
Return on sales (%)	8.6	11.3
Market capitalisation *(listed companies only)*	8.848	11.187

Sources: DB Research, JRC, 2011 3

The companies surveyed employed a combined workforce of more than 30 million people in 2009, generated turnover of EUR 8.6 trillion and made profits of EUR 738 bn. Their average R&D intensity[4] thus came to 3.7% and the average return on sales[5] to 8.6%.

The sample contains companies from 45 different industries (according to the Industry Classification Benchmark). The R&D intensity ranges between 0.1% and over 20% depending on the industry. This means there are also many companies that conduct

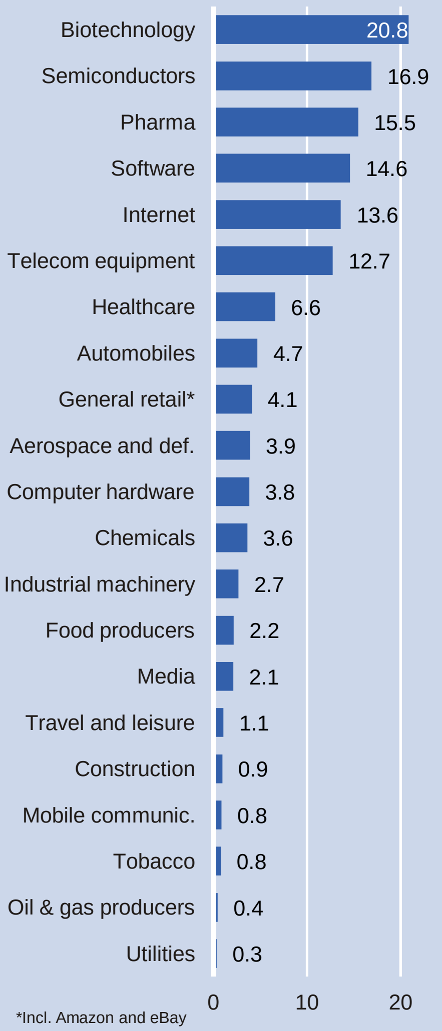
[3] Regarding the background, methodology and data quality of the R&D Scoreboards, see JRC (2010). Monitoring industrial research: The 2010 EU Industrial R&D Investments Scoreboard. European Commission. Joint Research Centre. Institute for Prospective Technological Studies. Seville. Spain.

[4] R&D expenditure relative to sales.

[5] Earnings relative to sales.

Wide range

R&D intensity, by industry (2009)

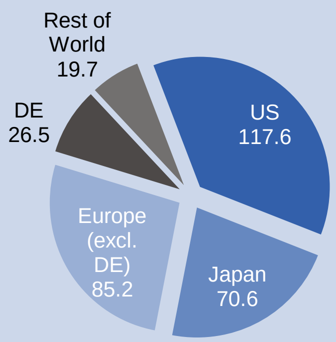


*Incl. Amazon and eBay

Sources: DB Research, JRC, 2011 4

The old world

R&D investments, EUR bn (2009)



Sources: DB Research, JRC, 2011 5

relatively little research but whose R&D budgets are considerable on account of their size. Deutsche Bahn, the largest railroad company in Germany, spends only 0.05% of its revenues on R&D. However, with a turnover of nearly EUR 30 bn this means it still spends EUR 16 m on R&D.

The highest R&D intensities are found in biotechnology (21%), semiconductors (17%), pharmaceuticals (16%) and among software (15%) and internet companies (14%). The lowest R&D intensities (all <1%), by contrast, are to be found in industries such as utilities, tobacco, oil & gas producers and – perhaps surprisingly – mobile telecommunications (see chart 4).

Compared with official industry statistics, for example those supplied by the OECD, the R&D intensity of the industries in this sample is slightly higher. This is because it is highly likely that the companies which conduct the least research in their respective industries are not taken into account. The deviations are small overall and not systematically biased, though.[6]

Within an industry the R&D intensities are by no means uniform. This is because, on the one hand, firms within a single industry will be in different phases of their development: those with catching up to do may have to invest more in R&D in order to make up ground. Also, within several industries there are a variety of business models in use. The pharmaceuticals industry, for example, consists both of companies at the cutting edge of research carrying out very costly development of innovative drugs as well as firms that manufacture generics. The latter firms focus on cost-efficient production of already well-known pharmaceuticals, and accordingly invest less in R&D. In the end, the industry definition is not always granular enough: the leisure goods industry, for instance, contains companies such as Electronic Arts, Bang & Olufsen and Mattel. In this case the diversity of the products and their differing technology components explain a large proportion of the research variance. Furthermore, some firms, for example conglomerates, operate in several industries but are only classified according to their main area of business. This can also lead to discrepancies.

US firms dominate

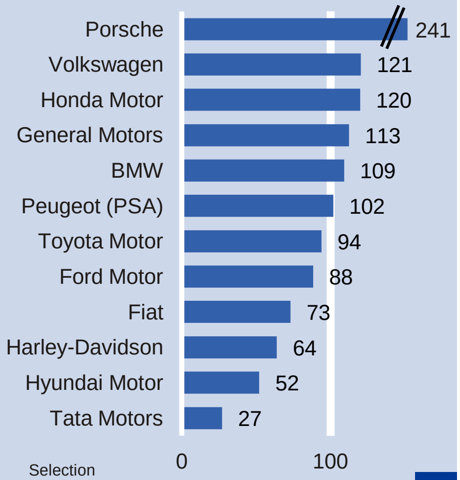
The regional origin of the companies reflects the Old World above all. The bulk of R&D spending is made by firms from the US, Europe or Japan (see chart 5). In 2009 only 44 of the top technology firms were headquartered in emerging markets.[7]

However, it should be noted that all R&D investments are assigned to the company's head office location, regardless of whether the expenditures are made in the home market or abroad. In official R&D statistics, for example those published by the OECD, the R&D investments counted are typically only those where spending has actually occurred in the corresponding country. The focus on a company's head office location tends to understate the very role of emerging markets given that they have become successfully integrated into international research networks over recent years. For example, the R&D expenditure of Siemens, a German engineer-

[6] According to OECD data and the VAT statistics for the automotive and chemicals industries and mechanical engineering, for example, the research intensities of German companies in the sample are 1-1.5 percentage points higher than in the respective industries as a whole. The OECD does not, however, provide any data at the company level.

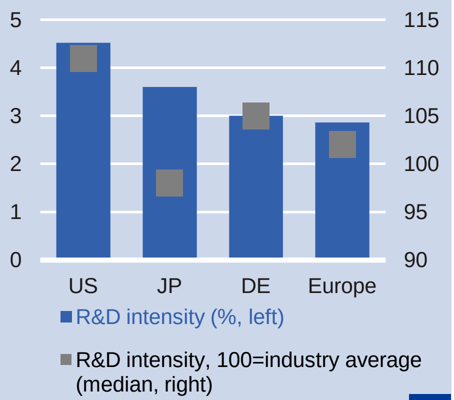
[7] Even fewer firms from emerging markets were continuously in the top 1,000 and could be included in this analysis.

Vroom, vroom
R&D intensity, 2009
(100=industry average)



Selection
Sources: DB Research, JRC, 2011 6

US is technology leader
R&D intensity (2006-2009)



Sources: DB Research, JRC, 2011 7

ing group, is ascribed to its head office location in Germany although 19% of its research team works in the BRIC countries.[8]

Some 44% of technology firms are headquartered in Europe; they account for only 35% of the R&D budget, though. This is partly because small European firms are overrepresented in the sample since a smaller R&D budget is sufficient to gain admission to the European Top 1,000 compared to the non-European list. But also in terms of R&D intensities – that is taking into account the different company sizes – US firms have their noses in front. Their average R&D intensity is 4.5%; for European firms, by contrast, the figure is just 2.9%.

US firms have an above-average presence in particularly research-intensive industries: pharmaceuticals, biotechnology, and in the IT and software businesses. In Europe it is the automakers, by contrast, that supply the largest share of the R&D budget. Their research intensity is only average, however.

The interesting question is whether there are also differences within the industries. In order to be able to make a systematic comparison of R&D intensities we proceed to calculate the R&D intensity of every company in the sample relative to the international industry average. Chart 6 shows the results for selected examples in the automobile industry: the R&D intensity of the sports car manufacturer Porsche is nearly 2 ½ times the international industry average. The Indian automaker Tata Motors, by contrast, invests with an R&D intensity that is only a little more than one-quarter of the industry average.

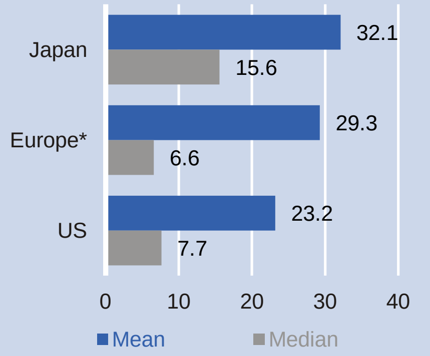
Incorporating the respective industry average enables the relative R&D intensity of the companies to be compared across industries. This reveals that US companies are not only represented particularly often in research-intensive industries but also that US firms within the industries often boast an above-average R&D intensity. The median for all US companies is 111, which means that 50% of all US companies have an R&D intensity that is at least 11% higher than the respective industry average. In Europe the median is 102, in Japan it is 98 (see chart 7).[9] Industry mix alone thus does not account for the leading role of US firms.

Keiretsu or start-up?

The situation in Japan is particularly striking: although Japanese firms are frequently to be found in relatively research-intensive industries, their investment in R&D within these industries is merely below average. The median in Japan is lower than the European median. One important reason for this is that the Japanese company landscape is ruled by large long-established groups. On average a Japanese company in this sample employs 32,100 people. This figure is much higher than in Europe and the US (see chart 8). Big companies, however, typically have a lower R&D intensity than the small companies and start-ups in our sample (see chart 9).

[8] See Meyer, Thomas, 2010. International division of labour in R&D: Research follows production. E-conomics 82. DB Research. Frankfurt am Main.
[9] The median of all the countries is 103, which means that a small majority of firms have an above-average R&D intensity. This is because above all many small businesses have a sometimes very high R&D intensity but because of their small size have hardly any influence on the mean.

Giant or start-up?
Employees per company ('000), 2009



*Small European firms are oversampled

Sources: DB Research, JRC, 2011

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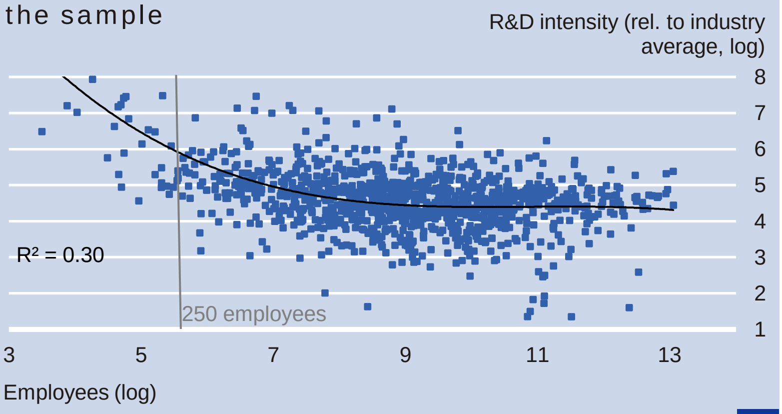
Only super-innovative small firms make it into the sample



Sources: DB Research, JRC, 2011

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This effect is amplified by a special feature of this sample. Small firms are only to be found in the sample if they have a particularly high R&D intensity. Only these firms have the required R&D budget despite their smallness. Small firms that are weak on innovation, by contrast, simply do not make it on the list. This means the sample is skewed with regard to small companies (selection bias). The relationship disappears at companies with more than around 250 employees.[10]

How do small firms achieve such high R&D intensities? Aspiring young technology firms have to first develop their product range before they can generate revenues. This sends R&D intensities rising sharply as R&D spending is considerable, while revenues are (still) low. At larger, more established companies, by contrast, research investments are matched by revenues from ongoing business. This typically reduces R&D intensities. At large companies economies of scale also become more important, which means that research expenditure is spread across a large volume of output. The costs per unit and thus the R&D intensities decline. Especially in the established industries (such as automaking) this generates heavy pressure for consolidation.

Japan's technology companies are heading into old age

Companies in the US are distinguished by a strong start-up culture.[11] Over 50% of all US firms in the current Top 1,000 were founded after 1975, in Europe the figure is just 18% and in Japan a mere 2%.[12] US firms thus invest more in R&D than their competitors in Europe and Japan also on account of their youth and their smaller size. The start-up culture also explains why US firms call the shots in advanced technology sectors. Biotechnology, software and IT are business areas that did not even exist until very recently. Long-standing companies find it difficult, however, to tap into these new business areas.[13] That is why it is mainly the relatively young (former) start-ups that are successful in these areas. The potent

[10] Jaruzelski et al. (2005) work with a similar sample (the 1,000 biggest corporate R&D spenders) and confirm this effect (Table 3, p. 8). However, they attribute the effect primarily to potential economies of scale at big companies and arguably underestimate the skewed distribution at small companies.

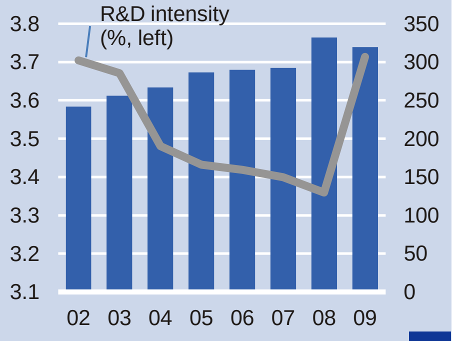
[11] See Meyer, Thomas, 2009. Brave new firms. High-Tech entrepreneurship in the United States. E-conomics 75. DB Research. Frankfurt am Main.

[12] The assertion is based on the Top 1,000 lists for 2009, not on the adjusted sample. See JRC (2010). p. 51ff.

[13] See Meyer, Thomas, 2008. Venture Capital: Bridge between idea and innovation? E-conomics 65. DB Research. Frankfurt am Main.

Sales outpaced R&D – up until crisis

R&D investments, EUR bn (right)



Sources: DB Research, JRC, 2011 10

start-up culture in the US consequently ensures the major presence of US firms in the young high-tech industries.

Sales outpaced R&D – until the crisis

The firms in the sample increased their R&D investments in the period 2002 to 2009 by an average of 4% p.a. In the economic boom years following the turn of the millennium; however, sales climbed much faster (by 7% p.a.). As a result average R&D intensity fell from 3.7% (in 2002) to 3.4% (in 2008).

This development shows that R&D intensities are not an unambiguous indicator of corporate innovative capacity. It is ultimately a confirmation of the success (also) of R&D when sales rise faster than R&D spending, even if R&D intensity thereby declines – for mathematical reasons.

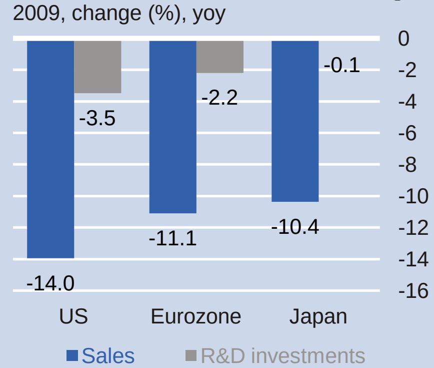
Not until the crisis year 2009 were there slumps in both sales and R&D investment. Most companies have nevertheless gone easy on their R&D budgets: while sales have fallen by 13% overall, companies have cut back their R&D spending by only 4%. As a consequence R&D intensity rose again to 3.7% in 2009 (see chart 10).[14]

Innovative firms bank on R&D – especially during a crisis

The comparatively stable development in R&D investments reflects, on the one hand, the latency present when expanding or contracting research capacities. In crisis periods, too, fixed costs are still incurred: R&D personnel cannot be summarily dismissed, and contracts with research partners have to be honoured. In addition, it would often make no business sense to shelve innovation cycles already in progress as invested funds would then be wasted. Furthermore, it is precisely those companies at the cutting edge of technology that tend to invest more in R&D during phases of mounting competitive pressure in order to set themselves apart from their competitors.[15]

R&D reacts with a time lag

2009, change (%), yoy



In local currency

Sources: DB Research, JRC, 2011 11

US firms respond faster

Firms in the US have been hit particularly hard by the crisis. Sales slumped 14% and they cut their R&D budgets by 3.5%. The setback in the eurozone was slightly weaker and the companies cut back their R&D investments by just 2.2%. Japanese firms even kept their R&D budgets nearly constant despite an only minimally smaller slump in sales (see chart 11).

At the same time US firms had to book the smallest decline in profits (-7% in 2009), while eurozone corporate earnings dropped by 21% and in Japan profits nosedived by no less than 82%.

The differing reactions undoubtedly also reflect the greater flexibility in the way that US companies are organised, i.e. adjustments to the R&D budget can be implemented faster. Also, there is less tolerance of low profits in the capital market-driven US than in Europe or Japan. As a consequence management has to respond to losses more rapidly and resolutely.

Are research-intensive companies more successful?

Our sample of 1,209 firms provides a good opportunity to empirically examine the success of R&D at the company level. The guiding

[14] R&D investment peaked at EUR 332 bn in 2008, which was also due to the comparative weakness of the euro in that year. The comparison in chart 11 uses national currencies.

[15] See Meyer, Thomas, 2010. Innovative capacity in the aftermath of the crisis: German companies banking on R&D. E-conomics 80. Frankfurt am Main.

Overview of the variables

Employees	Number of employees
R&D 02/05	R&D intensity, relative to industry average (%), 2002-2005 mean
R&D 06/09	R&D intensity, relative to industry average (%), 2006-2009 mean
R&D	R&D intensity, relative to industry average (%), 2002-2009 mean
Market capitalisation	Market capitalisation / sales, relative to industry average (%), 2006-2009 mean
Productivity	Sales per employee, relative to industry average (%), 2006-2009 mean
Return on sales	Centred on industry average, 2006-2009 median
Sales growth	Change 2006-2009 (%)
Volatility	Variance of the return on sales 2005-2009

Source: DB Research, 2011 12

question is whether investments in R&D actually pay off in the form of a higher return or market capitalisation.

Many company metrics are dictated by the industry. The retail sector, for example, typically has a lower return on sales than software manufacturing for instance due to the high costs of sales. A carmaker that invests 10% of sales in R&D would be very innovative – a pharma company with the same R&D intensity would be weak on research. So to avoid comparing apples with oranges the most important figures are weighted with the industry average (in line with the example in chart 6). Research-intensive companies are thus those that invest more in R&D than the industry average; successful companies have a higher valuation or achieve a higher return than their industry average.

Since typical innovation cycles have a duration of several years, short-term fluctuations provide little conclusive information about the influence of R&D. This report therefore uses average values for the years 2006 to 2009. Although the year 2009 was marked by the crisis, the weighting with the industry average directs the focus onto relative performance and not onto absolute figures. In addition, the average R&D investments for the period 2002-2005 are used to test what influence R&D has on future performance metrics.

Profits and market capitalisation are the indicators of business success. Both metrics are set against sales to factor in differences in company size. Also serving as indirect indicators are labour productivity, sales growth and volatility of returns. Table 12 provides a summary of all the variables used and their respective dimensions.

An initial overview of the relationships is supplied by a simple correlation matrix of the variables (see table 13). A remarkable observation is that the R&D intensity is very stable over time. Companies that made above-average investments in R&D during the first period (2002-2005) were most probably also among the research-intensive firms in their industry in the next period (2006-2009). This applies regardless of region.

R&D intensity stable over time

Correlation matrix for key company ratios

	R&D 06/09*	Employees*	Sales growth	Productivity*	Volatility* of return on sales*	Return on sales	Market capital-isation*
R&D 02/05*	**0.88**	-0.28	0.14	-0.05	**0.30**	**-0.31**	**0.31**
R&D 06/09*		-0.28	0.08	-0.06	0.28	-0.23	**0.31**
Employees*			-0.07	0.07	**-0.45**	0.21	0.00
Sales growth*				-0.04	0.03	-0.26	0.17
Productivity*					-0.07	0.20	0.07
Volatility*						**-0.34**	0.06
Return on sales							0.10

*Expressed in logarithmic form

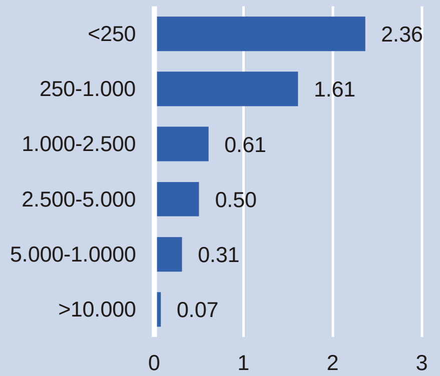
Only companies with more than 250 employees. N=1,139

Sources: DB Research, JRC, 2011 13

Although the matrix only covers firms with more than 250 employees (for smaller firms our sample is biased – as explained) it also applies within this limited sample that large companies with several

Size keeps risk in check

Impact of R&D expenditure on volatility, by headcount

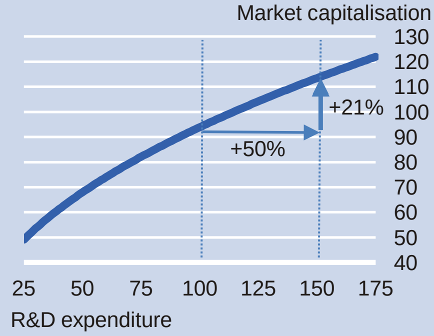


Regression coefficients:
Log(volatility) = c + β log(R&D 06/09)

Source: DB Research, 2011 14

Stock market rewards R&D

Relative to sales, 100=industry average



*Based on coefficients from model 1; companies with an average number of employees

Sources: DB Research, JRC, 2011 15

Equity or debt capital?

Market capitalisation takes into account only the value of equity capital and not debt capital. R&D can, however, generate very different effects depending on the type of capital. After all R&D increases not only expected profits but also risk. This can result in R&D leading to a redistribution of enterprise value to the benefit of shareholders and to the detriment of lenders, since lenders do not benefit from additional profits but are exposed to additional risk. This effect would exaggerate R&D elasticity, since the loss made by the lender would be ignored. More recent research cannot confirm this effect, however.

Literature

Shi, Charles (2003). On the Trade-Off Between the Future Benefit and Riskiness of R&D: A Bondholders' Perspective. Journal of Accounting & Economics 35. pp. 227-254.

Eberhart, Allen, William Maxwell and Akhtar Siddique (2007). A Reexamination of the Tradeoff between the Future Benefit and Riskiness of R&D Increases. Journal of Accounting Research. Vol. 46. No 1. pp. 27-52.

thousand employees tend to have a lower R&D intensity: this may be due to economies of scale or other reasons. What also becomes clear, however, is that with the size of the companies profits become significantly more stable – the volatility declines. This comes as no surprise, after all large firms are more often diversified and possess established business activities: both of these stabilise profits.

The size effect probably also explains why R&D expenditure is negatively correlated with return on sales and positively correlated with the volatility of return on sales. Smaller companies in this sample invest more in R&D, but are riskier and have a lower return on sales – because they are often still in the process of establishing themselves (see chart 14).

R&D spending is positively correlated with market capitalisation. The size effects does not play a role in this case since market capitalisation is independent of the number of employees. So there is a lot to suggest that research is indeed rewarded by the stock market. In order to isolate the impact of research expenditure even more precisely we shall go into greater depth with the analysis in the next section.

A company with an R&D intensity 50% higher than the sector average has a 14-21% higher market capitalisation

An extensive empirical analysis – the results are shown in table 16 – confirms first of all the positive influence of R&D expenditure on market capitalisation. The relationship is economically and statistically significant and takes into account numerous control variables.

The measured coefficient expresses the R&D elasticity: an increase in R&D intensity of 1% relative to the industry average is associated with a statistical rise in market capitalisation of 0.3-0.5% – depending on the model specification. In other words, a company whose R&D intensity is 50% higher than the industry average has a market capitalisation (relative to sales) that is 14-21% above the industry average (see chart 15).

It may be disappointing that additional R&D spending is only correlated with a disproportionately small increase in market cap. Nevertheless the different dimensions need to be taken into account: the market capitalisation is usually many times higher than spending on research. This means that even if the increase is disproportionately small investments in R&D can represent good business.

Overall, the models account for between 20% and 47% of the variation in the dependent variable. This is a very good reading given the fact that market capitalisation is influenced by many company-specific factors (e.g. concrete successful innovations, business model, quality of management) that cannot of course be factored into such a quantitative analysis.

What is the influence of the control variables?

Company size – in terms of number of employees – is positively correlated with market capitalisation in nearly every case. This does not necessarily mean though that the stock market invariably favours big companies. Rather it shows the special nature of the sample as it contains only those small companies that have a high or very high R&D intensity. The result is that a small size is equivalent to a high R&D intensity and that the influences overlap (multicollinearity). If the sample is limited to companies with at

Research and development boost enterprise value

Dependent variable: market capitalisation*

	(1)	(2)	(3)	(4)	(5)	(6)
C	2.018	1.598	1.808	1.575	3.419	2.798
R&D*	0.466*** (0.037)	0.392*** (0.038)	0.387*** (0.037)		-0.399*** (0.147)	0.316*** (0.033)
R&D*^{2}					0.084*** (0.015)	
R&D 02/05*				0.170*** (0.062)		
R&D 06/09*				0.227*** (0.068)		
Employees*	0.037** (0.015)	0.063*** (0.016)	0.056*** (0.017)	0.063*** (0.016)	0.064*** (0.016)	0.009 (0.013)
Employee growth		0.001*** (0.0003)	0.001** (0.0003)	0.001*** (0.0003)	0.001*** (0.0003)	0.001*** (0.0002)
Productivity*		0.098** (0.046)	0.068 (0.046)	0.099** (0.046)	0.105** (0.046)	0.016 (0.036)
Sales growth		0.001*** (0.0002)	0.001* (0.0008)	0.001*** (0.0002)	0.0004*** (0.0001)	0.0006** (0.0003)
Return on sales		-0.001*** (0.0002)	0.007** (0.004)	-0.001*** (0.0002)	-0.0004* (0.0002)	0.0465*** (0.0030)
Volatility*		0.014 (0.013)	0.026** (0.032)	0.016 (0.013)	0.0004 (0.013)	0.0514 (0.011)
R^2	0.22	0.27	0.20	0.27	0.29	0.47
N	984	984	950	984	984	934
			>250 employees			>250 employees; return on sales between -50 and +50

*Log, standard error in parantheses (using White correction). Significance levels: *10%, **5%, ***1%

Source: DB Research, 2011

16

least 250 employees and we ignore firms with unusually high or low returns on sales, then the number of employees loses its statistical significance (see model 6).

Company sales play a key role for many variables as a reference value: both R&D spending and market capitalisation are weighted according to sales. When sales decline, there is a purely statistical rise in R&D intensity (R&D expenditure is mostly adjusted only after a time lag) and the weighted market capitalisation. This can result in the relationship between R&D intensity and weighted market capitalisation being overestimated. The models address this effect by firstly calculating averages over several years – the impact of short-term fluctuations is thereby reduced – and secondly, factor in sales growth as an additional control variable.

Growth generates momentum

Both sales growth and increased job creation are positively correlated with market capitalisation. This suggests there is a certain momentum, since market participants evidently expect positive performance in future as well. This is not to be taken for granted; after all, rapid sales growth could also have meant that a company has exhausted its growth options, which should tend to have a negative impact on market capitalisation. This does not seem to be the case, however.

Labour productivity is also positively correlated with market capitalisation. However, this effect disappears if the sample is limited to larger companies with more than 250 employees (models 3

No, yes, perhaps

Dependent variable: return on sales

	(7)	(8)	(9)
C	-12	-23	-29
R&D*	-4.9*	0.7*	0.27
	(2.51)	(0.39)	(0.41)
Employees*	0.64	0.99***	1.5***
	(0.58)	(0.20)	(0.20)
Job growth	0.03	0	0
	(0.02)	(0.00)	(0.00)
Productivity*	7.6***	2.57***	2.64***
	(2.00)	(0.68)	(0.66)
Sales growth	-0.1	0.01	0.01*
	(0.08)	(0.00)	(0.00)
Volatility*	-3.2	-1.2***	
	(0.00)	(0.21)	
R^2	0.23	0.12	0.08
N	1010	994	994
	>250 employees	>250 employees; return on sales between -50 and +50	

*Log, standard error in parentheses (including White correction). Significance levels: *10%, **5%, ***1%

Source: DB Research, 2011 17

and 6) – similar to that in the matrix in table 13. Labour productivity is heavily influenced by capital employed: turnover per employee amounts, for example, at oil and gas producers to more than EUR 800,000 whereas in some service segments a figure of less than EUR 200,000 is common. However, the analysis already factors in sector-typical differences via the weighting.

Investors accept low returns on sales at small innovative companies

The return on sales is another important success metric along with market capitalisation, after all it expresses the earnings per unit sold. We start by investigating the influence of return on sales on market capitalisation. The results delivered by the models are mixed: while return on sales is typically negatively correlated with market cap (models 2, 4 and 5), the coefficient becomes positive when the sample is limited to larger companies (models 3 and 6). Here, too, the above-mentioned size effect can be observed: small innovative firms are given higher stock market valuations – this reflects their prospective growth potential. In the case of larger companies, by contrast, investors attach greater value to a higher return on sales. It is also interesting that the influence of return on sales grows markedly when outliers are removed from the sample – at the same time the size of the workforce loses its statistical significance (model 6).

The volatility of the return on sales has no direct influence on market capitalisation in most of the models. Only in model 2 there is a positive influence that is of low statistical significance. This may come as a surprise, after all investors should – all other things being equal – prefer stable earnings. Indeed model 6 shows that this positive influence is presumably caused by a few outliers: in this model, which excludes firms with very high or very low returns on sales, the volatility is not statistically significant.

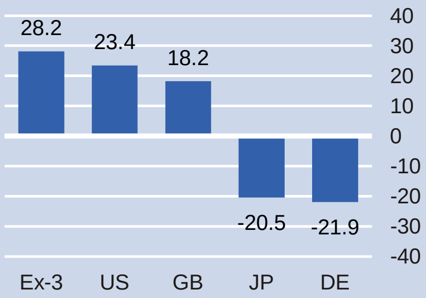
It is also interesting whether R&D expenditure is directly correlated with the return on sales. The results, again, are mixed. Models 7-9 estimate the influence of R&D intensities on return on sales (see table 17). Depending on the model specification the correlation between R&D expenditure and return on sales is either negative, positive or nonexistent. The outcome in fact depends very much on the composition of the sample. If the sample is limited to companies with more than 250 employees (model 7), the coefficient is negative – in the same way as in matrix 13. If outliers with very high or very low returns on sales are ignored, the coefficient is positive (model 8) or insignificant (model 9). The difference between the latter two models is that model 8 factors in the volatility of the return on sales as a control variable – unlike model 9 which does not. Since volatility is positively correlated with R&D expenditure and negatively with return on sales, it therefore acts like a filter that strips out some of the negative correlation between R&D and return on sales. Overall, the impression remains that R&D intensities have no robust systematic influence on the return on sales. The results react too sensitively to changes in the variables and samples employed.

Differences between industries and regions

The analysis has shown that there is a robust correlation between R&D expenditure and the market capitalisation of research-driven companies. In this section the aim is to go into greater depth with this analysis and draw distinctions between the regions and industries. This should give an impression of the regional and

Higher valuations in capital market-based systems

Market capitalisation, relative to Europe (excluding Germany/UK), %

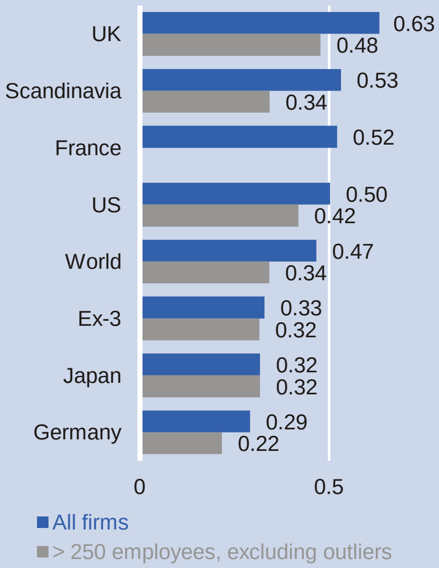


Market capitalisation relative to sales weighted by the industry average. Other things being equal (in keeping with model 3). All regional dummy variables are statistically significant at least at the 5% level.
Ex-3: companies based outside the US, Europe or Japan

Sources: DB Research, JRC, 2011 18

Germany brings up the rear

R&D elasticity by company head office location (model 1)



All coefficients for R&D are statistically significant.
Ex-3: companies based outside the US, Europe or Japan

Source: DB Research, 2011 19

industry-specific differences and also provide a further indication of the stability of relationships measured. If certain correlations were only to occur in a few regions or industries, this would be a sign of insufficient robustness.

Most firms in the sample are global players. All the same, it shows that Anglo-American firms as well as companies based outside the US, Europe or Japan (in the so-called Ex-3 countries) obtain higher valuations than continental European or Japanese companies. US companies for example have a market capitalisation that is 23% higher on average than comparable European companies (excluding DE/GB) (see chart 18). Note that the differences in industry mix between the various regions are not a factor here as the market capitalisation was weighted with the respective global industry averages. Rather, it is the different cultures of companies and investors that arguably play a part. It is certainly no coincidence that it is the very firms from capital market-based countries, the US and the UK, which have a higher valuation than companies from continental Europe or Japan.

Also companies based outside the traditional centres of innovation of the US, Europe and Japan obtain a higher valuation, all other things being equal. These valuations also reflect the high expectations for macroeconomic growth. Of all 78 firms in this region, most are headquartered in south-eastern Asia: Taiwan (29), South Korea (11) and China (7 incl. Hong Kong).

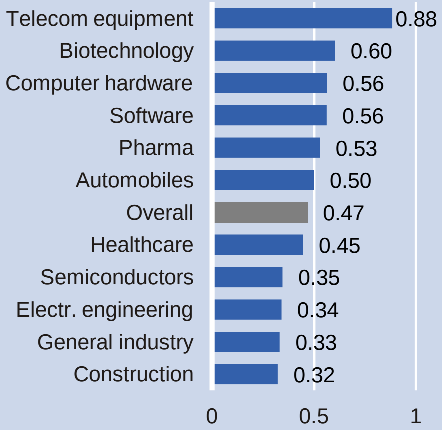
Given the differing valuations investments in R&D could also have a different effect on market cap depending on where the company is based. We therefore calculate model 1 from table 16 separately for different countries and regions (as long as enough companies have their head office in these regions to obtain statistically meaningful results). The definition of the industries always remains global. Basically we identify a positive, statistically significant relationship between R&D and market capitalisation in most countries and regions. This suggests that the results are robust. However, the strength of the effect depends on the region. We measured the highest elasticity among British companies, followed by Scandinavian, French and US companies. Firms based in Japan or Germany, by contrast, demonstrate only below-average elasticity on a global comparison (see chart 19).

Overall, the pattern in chart 19 is similar to the findings in Hall and Oriani (2006): they also measured the highest elasticity in the UK and the lowest in Germany. French firms are closer to German readings in their analysis. However, the elasticity of French and Scandinavian firms in our analysis reacts sensitively to outliers. If small companies and firms with very high and very low returns on sales are ignored, the reading for France is no longer statistically significant and the value for Scandinavia moves much closer to Germany's. Like Hall and Oriani (2006) and Duqi and Torlucci (2010) we find no statistically significant effect for Italian companies.

The typically lower valuation level for German and Japanese firms probably explains some of the lower elasticity. But this explanation cannot apply to companies based outside the US, Europe and Japan (Ex-3): their elasticity levels are similarly low despite having a higher valuation on average. For their valuations, however, macro-economic growth expectations probably play a more important role than innovation. After all, many companies in these regions are not operating at the cutting edge of technology, which means that R&D is less important.

High elasticity in innovative sectors

R&D elasticity from model 1, by industry



Only statistically significant coefficients with a sufficiently large number of cases

Source: DB Research, 2011 20

High elasticity in innovative industries

The relationship between R&D intensity and market capitalisation is particularly strong in research-intensive industries (see chart 20). This is a finding that has already been established in the literature. Nevertheless, R&D also has an impact in less innovative industries such as construction.

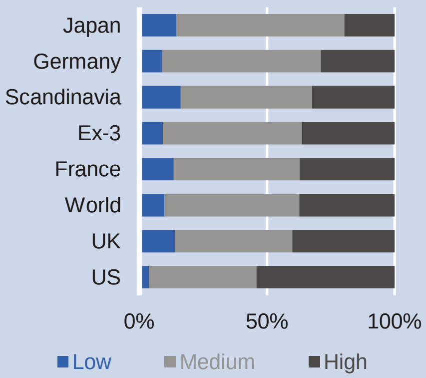
Countries with an above-average share of research-intensive industries ought to also have a higher overall R&D elasticity for this reason alone. Indeed it is especially the US and the UK that are home to particularly large numbers of companies from industries with high R&D intensity (see chart 21). The high R&D elasticity in these countries could thus simply be the consequence of the industry structure and not have any country-specific causes. This would be a very important factor in interpreting the differences as it would call into question the role of the US and the UK as models for other countries.

The country comparison shows that the share of companies from industries with a high R&D intensity accounts for one-third of the variation in the R&D elasticities (see chart 22). About two-thirds of the variation is not explained by the industry structure and has other causes or is due to chance. This impression is confirmed by closer analysis. We calculate the R&D elasticity from model 1 once again for all countries, however, only with companies from industries with medium or low R&D intensity. Industries with high R&D intensity are excluded. The sample that then remains is much more uniform in its research intensity; differences in the measured R&D elasticities are thus more likely to be due to country-specific factors – and not to the structure of the industry.

Chart 23 shows that the basic structure and order of R&D elasticities remains unchanged: the UK and the US continue to occupy the top spots; Japan and continental Europe bring up the rear. Only Scandinavia did somewhat worse than before. Since the sample is now smaller, no statistically significant values can be determined for Germany and France, so we focus on the whole of continental Europe.[16] Overall, the R&D elasticities are lower than before. After all, the particularly research-intensive industries are not included.

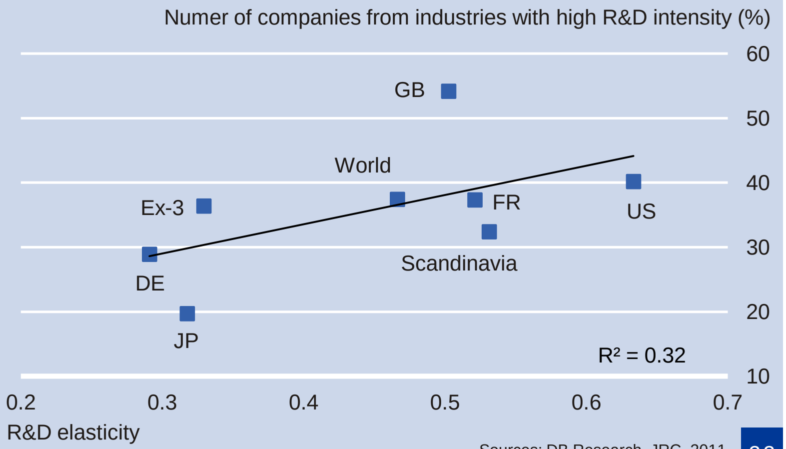
Industry structure...

Number of companies, by R&D intensity of the industry (%)



Sources: DB Research, JRC, 2011 21

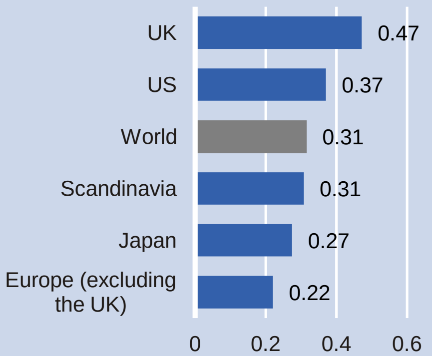
...provides only a partial explanation



Sources: DB Research, JRC, 2011 22

The pattern remains

R&D elasticity mirrors that of model 1, only low-research industries



Only industries with average and low R&D intensity

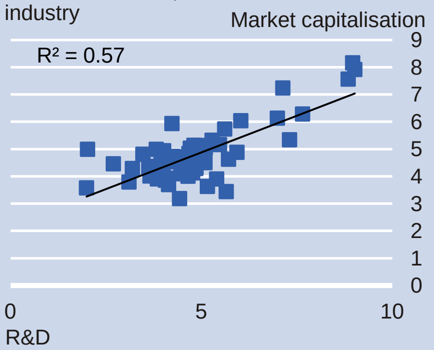
Sources: DB Research, JRC, 2011 23

16 Just 79 German companies and 44 French companies are left in the sample.

There is thus a reciprocal relationship between industry structure and R&D elasticity at the country level. On the one hand, country-specific factors have a measurable influence on R&D elasticity. On the other, high R&D elasticity promotes the development of research-intensive industries. This has repercussions for R&D elasticity, since the larger the share of research-intensive industries, the higher the R&D elasticity of the economy as a whole. The industry structure is thus both a determinant and a product of the R&D elasticities. By using specific industries the following examples are intended to illustrate the relationship between research and market capitalisation.

Tomorrow's blockbusters

Relative to sales, pharmaceuticals industry



Expressed in logarithmic form. Definition of the variables corresponds with table 12.

Sources: DB Research, JRC, 2011 24

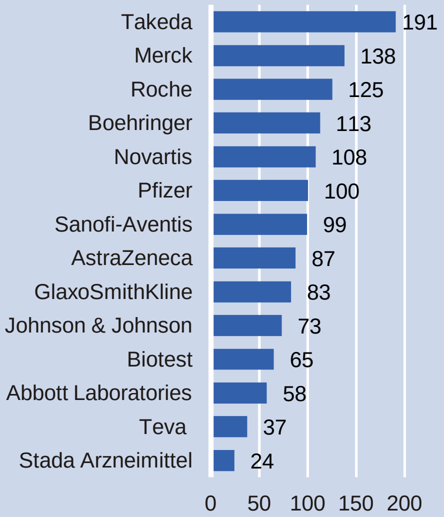
Differing business models in the pharmaceuticals industry

In the pharmaceuticals industry, too, research-intensive companies attract higher stock market valuations (see chart 24). In this very industry new, patented medicines promise above-average returns for research-driven companies. Novel medicines are often the only alternative method of effectively treating an illness. Given the lack of substitution options and a high readiness to pay for healthcare high margins can be earned on such blockbuster drugs. The research expenditure on new medicines is, however, extremely high. Among other things, new products have to be tested for potential side effects in extensive clinical trials that in some cases take years to complete. The fact that, at the same time, numerous product development projects ultimately prove to be unsuccessful exposes research-driven companies to major risks. Generics manufacturers, by contrast, specialise in manufacturing blockbuster drugs as soon as their patents expire. In this segment the research intensity is much lower.[17] These differences are reflected in the range of R&D intensities in this industry (see chart 25).

Blockbuster v. generics

R&D intensity, 2009

(100=industry average)



Selection

Sources: DB Research, JRC, 2011 25

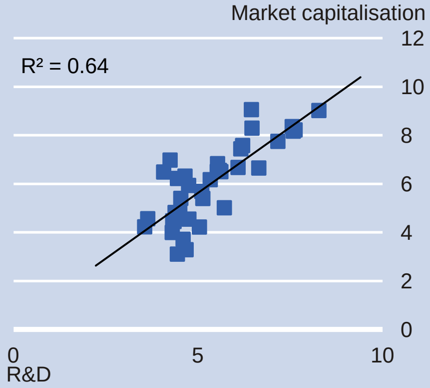
Fragmented value chain in the chip industry

The semiconductor industry is also home to a variety of business models. In the past, many companies in this industry performed every activity in the value chain themselves, from research, design and manufacturing right through to sales. Today there are many firms that are considerably more specialised and outsource many activities. Competition in the semiconductor business is becoming more intense as the market matures. Firms have to leverage their potential by specialising more heavily on individual product segments and process stages. For instance there are contract manufacturers, also known as foundries, that concentrate on producing semiconductors and manufacturing in large volumes. The research and design of the chips is carried out by other firms, while the foundries focus on the less research-intensive development of production processes. This means that there are very contrasting research intensities in this industry, too, in some cases. The business model for the foundries comes from Taiwan. This makes it interesting to compare the nine Taiwanese companies in the sample against the industry average: while the R&D intensity in the chip industry in Taiwan is 10% according to our data set, the reading for the remaining companies is nearly 18%. These differing research intensities do not, however, mean that firms in Taiwan are less successful. On the contrary: their market capitalisation is 3.7 times

[17] Since in the past only an ever shrinking fraction of research projects culminated in the launch of a new drug, the research intensity in the industry could become somewhat more uniform in future. After all, the firms at the cutting edge of research are reacting to their reduced success rates by cutting costs – also those incurred in product development.

R&D for the breakthrough

Relative to sales, biotechnology



Expressed in logarithmic form. Definition of the variables corresponds with table 12.

Quellen: DB Research, JRC, 2011 26

sales – for companies outside Taiwan, by contrast, the multiple is just 2.4. The example illustrates that besides R&D there are other factors that can prompt investors to be bullish about growth. The most important of these is the generally good growth outlook for the industry in this region.

High importance of research in biotechnology

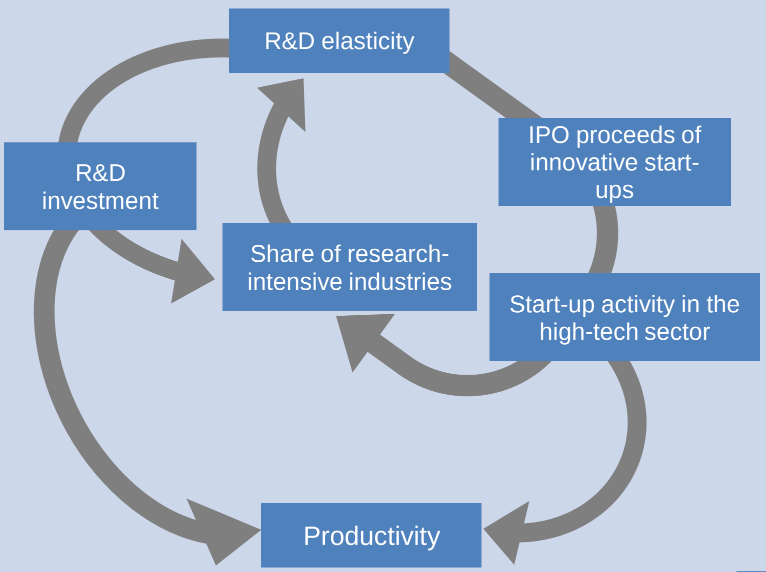
In biotechnology the research intensities of companies are much more similar (see chart 26). Unlike in the pharma industry there are no fundamentally different, co-existing business models. In the biotechnology industry entire production processes are developed. These processes are even considerably more difficult to reproduce than a drug. Firms in this sector therefore have no real alternative but to conduct intensive research themselves.[18]

In a relatively new high-tech field like biotechnology research can also be particularly lucrative, since companies have the opportunity to make a technological breakthrough and, for example, to establish a new standard. In this way they can generate huge royalties, if other firms use the technology and develop it. At present such enticing pioneer rents are on offer in areas such as cancer research or the process for converting biomass into oil, which is presumed to still hold great potential for boosting efficiency.

High R&D elasticity accelerates technological progress

How does the relationship between R&D investment and stock market valuation impact on the long-term innovative capacity of an economy? High R&D elasticity shows that the stock market values innovative companies more highly: this directly increases the incentive to invest in R&D and strengthens the market position of innovative firms in general. This benefits not only the existing technology companies, it also boosts the incentive to develop new, innovative firms (see chart 27).

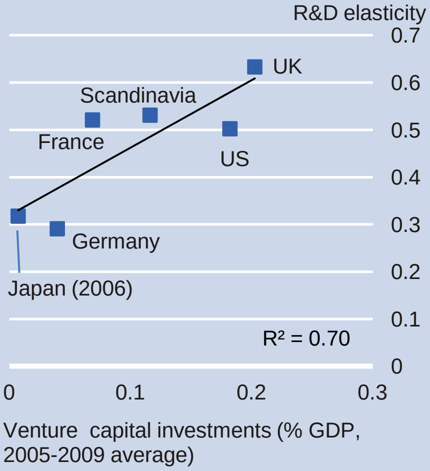
Capital markets reward R&D



Source: DB Research, 2011 27

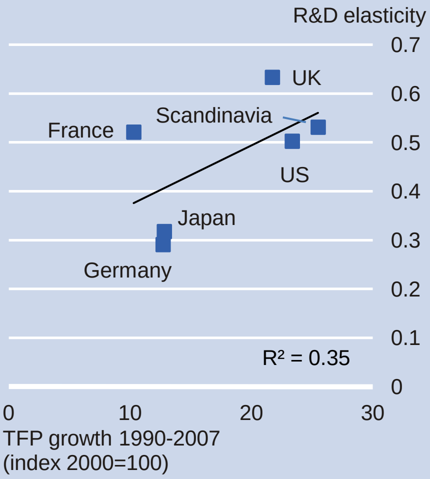
[18] This applies all the more so to the four German biotech firms in the sample, as biotechnology firms in Germany mainly conduct research and manufacture only few products themselves. The research results are sold to the pharma industry, which manufactures products based on these results. Since the industry in the US is already more developed, US companies dominate the sample.

High elasticity rewards innovative founders



Sources: DB Research, JRC, OECD, PwC, 2011 28

Productivity benefits



Sources: AMECO, DB Research, JRC, 2011 29

No slump during the crisis

R&D elasticity (in accordance with model1)

All coefficients for R&D are statistically significant.
Ex-3: companies based outside the US, Europe or Japan.

Sources: DB Research, JRC, 2011 30

This effect is shown, for example, by the close correlation between R&D elasticity and the venture capital investments as an indicator of entrepreneurial activity with innovative start-ups (see chart 28). One reason for the higher VC activity in Anglo-American-oriented countries – but also in Scandinavia – is thus arguably that innovative companies subsequently achieve higher stock market valuations than in Germany or Japan for instance. This boosts the proceeds that successful start-ups generate on exit, and thus the profitability of the VC fund. Higher returns in turn attract new investors (fundraising) and fuel the VC cycle.

Overall, there is a clear relationship between R&D elasticity and the pace of technological progress. Chart 29 shows the correlation between R&D elasticity and the growth in total factor productivity (TFP) between 1990 and 2007. We take into account only the pre-crisis period in order to avoid crisis-related distortions. The correlation is essentially driven by two groups: group 1 contains the bank-based countries of Germany and Japan, which also have a low R&D elasticity; group 2 consists of the more heavily capital market-based countries, the US and the UK, that have a high R&D elasticity. France is an outlier in the chart (without it the correlation would be considerably higher), but the reading for France is – as described – not robust.

Stock market keeps faith with research even during crisis

The height of the economic and financial crisis occurred in 2009 with severe slumps in output, turnover and investment. Major uncertainty is an integral element of grave crises, because it results in households consuming less and companies investing less. Crises can also lead to the market taking a more sceptical view of innovations, since it is unclear whether the expected innovation returns can also be generated in future.

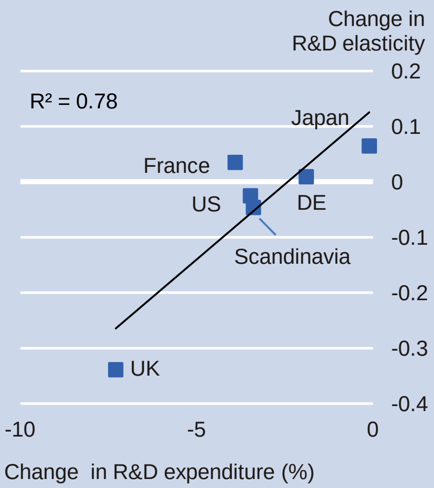
In order to examine this hypothesis we repeat the analysis of models 1-6. Instead of the average market capitalisation for the period 2006 to 2009 we use only market capitalisation in 2009. If research projects were treated with more scepticism by the stock market during the crisis, then the elasticity between market capitalisation and R&D intensity would have to be lower than in the previously calculated models.

We do indeed determine a statistically significant positive coefficient for the R&D intensity in the year when the crisis peaked. Overall, the explanatory power is lower than before, but this is also due to the fact that the market capitalisation of a single year (namely 2009) now serves as a dependent variable instead of an average of several years. This amplifies the impact of short-term, random fluctuations.

The elasticity in the crisis year 2009 was lower than before, which buttresses the argument that the stock market valuation was more sceptical. However, there is a sharp decline only in the UK, whereas in Germany, France and Japan the elasticity in 2009 actually increased. For the group of countries that does not include the US, Europe or Japan (Ex-3) we could determine not any statistically significant elasticity in 2009 (see chart 30).

The increased R&D elasticity, for example in Japan, shows that investors would hardly have accepted a radical cut in R&D expenditure. Correspondingly, Japanese firms largely went easy on their research budgets even during the crisis year. In the UK, where

Reaction to the crisis



Sources: DB Research, JRC, 2011 31

elasticity has more than halved, companies have also severely cut back on their R&D commitments (see chart 31).

Overall, the impression remains that investors value investments in R&D even during the crisis – it is only among British companies that the elasticity drops steeply. This is consistent with the findings made by Bloom and Van Reenen (2002), who analysed only UK firms. At the same time the British example is evidently not representative of other regions.

Conclusion: Capital markets are catalysts for innovation

Societies seek to improve the living conditions of their populations. In modern industrialised countries the only way to do this is by making smarter use of existing resources, personnel and machinery. Companies must develop more efficient production methods and desirable products. The degree to which the market rewards innovation ultimately defines the incentive to invest in research and development. The relationship between R&D and the success of an individual company, which we analyse in this report, also has a major impact on an industrial society's long-term technological progress.

This paper examines a large sample of 1,209 companies with a strong R&D focus from a variety of countries and sectors. For the first time, we are also able to measure the effect of the economic and financial crisis on R&D elasticity. The R&D elasticity shows how strongly a company's market capitalisation reacts to above-average R&D investment.

Research-driven companies achieve higher market capitalisation: firms with an R&D intensity 50% higher than their industry average (this applies to roughly 25% of all firms) achieve a market capitalisation that is 14-21% higher on average. This shows that investors appreciate long-term investment strategies, as R&D only pays off in the future. Hence, listed companies are by no means focused solely on the coming quarter. On the contrary: those who fail to create long-term growth options will be punished.

However, we do not see any robust correlation between relative R&D intensity and return on sales. This suggests that research-oriented companies primarily gain market share with their innovations rather than pushing through higher prices. On principle, this is good for the customer as long as product choice does not suffer too much. Also, refraining from hiking prices will have a disinflationary effect as quality improvements to innovative products do not seem to drive up prices.

The country comparison reveals that markets with high R&D elasticity also achieve greater productivity gains over the longer term. Moreover, the economic and financial crisis can serve as a natural experiment: how does R&D investment react to sudden changes in R&D elasticity? The crisis has prompted many investors to reassess R&D investment. They are particularly sceptical as regards R&D for companies domiciled in the UK: R&D elasticity there has more than halved since 2009. For German and Japanese companies, by contrast, it has actually risen. The following pattern can be observed for R&D spending: in 2009 British companies scaled back their R&D investment by more than 7%, while it remained relatively unchanged at German and Japanese firms. This shows that companies have followed investor perceptions.

Equity capital financing is of particular importance for research and development – for both young start-ups (venture capital) and established companies (stock exchange). The high level of R&D elasticity in the US and the UK may therefore also be a consequence of the breadth and depth of the stock markets.

Our paper demonstrates that modern financial systems are a catalyst for research and development. For companies this means that the market will reward new growth options and punish thinking that focuses solely on quarterly results. Investors are particularly called upon not only to assess the volume of R&D budgets but also their quality, strategy and translation into successful new products.

Thomas Meyer (+49 69 910-46830, thomas-d.meyer@db.com)

Philipp Ehmer

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