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Joint effect between R&D investments and market competition on stock returns: Evidence from developed European countries

Abstract

Firms that invest aggressively in research and development (R&D) are often riskier than other companies since their future earnings are more prone if an adverse situation occurs, and therefore have higher expected returns. Similarly, firms that operate in competitive industries are riskier since they have more rivals, and the likeliness that an R&D project has to be suspended is higher. This implies a strong positive joint effect between industry competition and R&D investment. In this paper, empirical evidence is provided to support the joint effect hypothesis, based on European stock and accounting data.

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1. Introduction and literature review

1.1. Introduction

According to the European Commission's 2018 Industrial R&D Scoreboard, EU companies have increased their investment in research and development (R&D) every year since 2009[1]. A Simple explanation is that investing in R&D is usually the most important thing when it comes to companies' long-term competitiveness. Especially, companies in competitive industries, for example in the automobile, health and ICT sector, often compete against their rivals on different R&D projects. These innovation races are important for every company since the first one to complete the R&D project will often force other firms to stop or abandon similar projects. Since the firm value is based on expected cash flows and they are affected by R&D projects, losing an innovation race and abandoning the project substantially decreases firm value.

In this paper, I study the joint effect between R&D investment and market competition on stock returns in developed European countries. I establish two hypotheses that are based on partial equilibrium model developed by Berk, Green, and Naik (2004): H1: Positive relation between R&D investment level and stock return is stronger in competitive industries, and H2: Positive relation between competition level and stock return is stronger among R&D-intensive companies. These hypotheses result in a joint effect that high competition and high investments in R&D have a strong positive interaction effect on the share price. In the model, the R&D project consists of different sequential stages that a company has to go through in order to complete the project. After the firm has completed all the needed stages, it receives a steam of cash flows from the invention. At any stage before completing the project, the manager has to make an investment decision, which maximizes the firm's future cash flows and therefore its market value. Prior to completing the project, the company knows its future cash flows from the project. If the firm decides to advance to the next stage, it will cause an investment cost for the company.

Competition risk is denoted by the obsolescence rate in the model, and it indicates the probability that the future cash flows are extinguished over the next stage. A higher rate expresses the higher probability that the cash flows will become zero and therefore lowers the benefits of R&D investments. This rate is usually higher for firms operating in competitive industries because they

[1] https://ec.europa.eu/jrc/en/news/2018-industrial-rd-scoreboard

often find themselves competing in innovation races to develop new technology and products. The winner of the race takes the market share to itself and other firms have to suspend or abandon their projects, which leads to zero future cash flows. Companies also have a certain threshold for the future cash flow and if this cash flow is not exceeded, the firm will suspend the project. A higher threshold means that the project is riskier since the probability that the project is abandoned or suspended increases if an adverse shock to the potential cash flow occurs. High R&D investment requirement raises the threshold since it lowers the value of the option to continue the project to the next stage. Thus, higher R&D requirement demands higher risk premium, and therefore firms that invest a lot in R&D have higher expected returns. To conclude, the model suggests that firms, which invest aggressively in R&D in competitive industries, have higher expected returns.

I use the double-sorting approach to test empirically the model's predictions and I show a positive joint effect between industry competition level and R&D-intensity. My findings show that positive relation between R&D level and stock returns exist in both, competitive and concentrated industries, but the relation is much stronger among competitive industries. The raw returns and abnormal returns in the asset-pricing models gradually increase when R&D-intensity increases. This is shown by all three asset-pricing models that I use: Fama-French three-factor model, Carhart four-factor model, and Fama-French five-factor model (see Fama and French 1992, 2015, and Carhart 1997). The pattern is shown when using all the firms in the sample and also when small stocks are excluded. For example, when microcap stocks are excluded, the monthly equally weighted three-factor alphas on high, medium and low R&D-intensity portfolios in high competition industries are 0.35%, -0.06% and -0.30%, respectively, with t-statistics of 2.08, 0.44 and 2.02. The return for the high-minus-low portfolio is 0.65% per month and is statistically significant at 1% level. In contrast, the three-factor alphas on high, medium and low R&D-intensive portfolios in low competition industries are 0.04%, -0.07% and -0.33%, with t-statistics of 0.28, 0.58 and 2.72, respectively. The return for the high-minus-low portfolio is 0.37% per month and is statistically significant at 5% level.

My findings also show that the positive relation between competition level and stock return exists only between R&D-intensive firms. The raw return and abnormal returns gradually increase among high R&D-intensity portfolios but this effect is not reported on the low R&D-intensity group. These findings can be seen on all three asset-pricing models when using either all firms or excluding microcap stocks. For example, when excluding microcap firms from the sample, the Fama-French three-factor model reports abnormal monthly returns among low R&D-intensity group on high, medium and low competition portfolios of -0.30%, -0.29% and -0.33%, respectively. T-statistics for the results are 2.02, 1.89 and 2.72. The return on the high-minus-low competition portfolio is 0.03% and insignificant. In contrast, the corresponding results for the high R&D-intensity group are 0.35%, 0.12% and 0.04% with t-statistics of 2.08, 0.83 and 0.28, respectively. The return on the high-minus-low competition portfolio is 0.31% and significant at 5% level.

The results show a strong relation to the existing literature. My findings show that there is a positive relation between R&D investments and stock returns. For example, Chan, Lakonishok, and Sougiannis (2001) found this relation in their paper. In addition, my findings suggest that firms in competitive industries earn higher returns than those in concentrated industries. This effect is studied by Hou and Robinson (2002), who found the same results. Gu (2016) found that among low competition industries, firms that invest aggressively in R&D do not make abnormal returns, but even generate negative excess returns. My findings do not follow this last statement.

This paper has two contributes to the literature. First, it shows the relation between R&D intensity and stock returns. (see, e.g., Lev and Sougiannis, 1996; Chan, Lakonishok, and Sougiannis, 2001; Chambers, Jennings, and Thompson, 2002; Eberhart, Maxwell, and Siddique, 2004; Hsu, 2009; Bena and Garlappi, 2011; Li, 2011; Lin, 2012; Hirshleifer, Hsu, and Li, 2013; Cohen, Diether, and Malloy, 2013). These prior studies show positive premiums among R&D-intensive firms. Second, this paper reports the relation between competition and stock returns in Europe. For example, Hou and Robinson (2002) find that firms in competitive industries outperform firms that operate in concentrated industries by earning higher returns on average. Aguerrevere (2009) reports that the relation between competition and stock returns varies along with product market demand.

The rest of the paper is organized as follows. Section 1.2 provides a literature review of R&D investments and stock returns. Section 2 describes the developing of hypotheses from the model. Section 3 provides the data and methodology. Section 4 reports the results. Section 5 shows robustness checks. Section 6 concludes.

1.2. Literature review

The relation between R&D expenditures and stock return has interested researchers for many decades. The evidence indicates that investors see R&D expenditures as investments that are going to produce benefits in the future and investors value these benefits when pricing stocks. In several papers, researchers have found abnormal returns for companies, which invest a lot in R&D. The positive relation between R&D intensity and abnormal returns is reported by Lev and Sougiannis (1996) and Chan, Lakonishok and Sougiannis (2001) who found that firms with high R&D value relative to market equity have an average excess return over the following three years is over 6% per year. Also, Lev, Sarath, and Sougiannis (2000) and Penman and Zhang (2002) report a positive relation between recent changes in R&D expenditures and stock returns. Firms that increase their R&D investments have significant abnormal returns. Finally, firms that announce new R&D investments, tend to have excess returns on their share during the announcement-period. For example, Chan, Martin, and Kensinger (1990), found that in the U.S. between 1979 and 1985, firms that announced plans to increase their research and development investments had statistically significant positive abnormal returns during the next two days after the announcement.

What makes intensive R&D firms generate abnormal returns then? This topic has been studied by Chambers, Jennings, and Thompson (2002) who tested two different reasons for excess returns. The first explanation could be that the stocks are mispriced because of the conservative accounting for R&D expenditures. Firms inform their R&D costs with caution that will make future earnings lower and that way affects the share price. The second reason could be that conventional risk controls do not fully capture the riskiness of high R&D companies, which is causing measured abnormal returns for these companies to be biased. Chambers at al. came to conclusion that positive relation between R&D expenditure levels and stock returns is more likely due to a failure in risk controls than from mispricing. However, their results do not rule out the possibility that abnormal returns are due to mispricing when studying the relation between R&D expenditure changes and stock returns.

R&D investments are not valuable only for companies that are doing well, but it can be significantly important for firms that are facing challenging times. Chan, Martin, and Kensinger (1990) found out that R&D announcements give positive returns also for firms that experience earnings decrease at the same time. In addition, Chan, Lakonishok, and Sougiannis (2002) found that firms that invest heavily in R&D but have poor past performance and cost-cutting pressures, tend to avoid the decrease in stock price. Investing in R&D informs managers' optimistic views about the company's future prospects even in bad situations. This highlights the fact that investors do not only value strategic investments that affect companies' short-term earnings but look beyond it when valuing a company's stock.

There have been findings of how R&D expenditures affect the stock price in different industries and market types. High investments do not always guarantee positive and abnormal returns, but the industry type is also a key factor. Gu (2016) study the R&D effect on different levels of market competition. His results from the U.S. stock market show that R&D-intensive firms only generate excess returns in competitive markets. R&D-intensive firms in concentrated industries do not generate excess returns and they even have negative returns. According to Chan, Martin, and Kensinger (1990), an increase in R&D spending is not rational in industries that are technologically mature. In high-technology industries, an increase in R&D yields significant positive abnormal returns but in low-technology industries, it generates significant negative returns.

2. Hypothesis

I follow the partial equilibrium model created by Berk, Green, and Naik (2004) to study the joint effect between industry competition and R&D investments on stock returns. In this model, the company operates in continuous time and advances through the R&D project in sequential stages. After the firm successfully completes N amount of separate stages and completes the project, it receives a stream of cash flows. At any time before the final stage and completing the project, the manager of the firm has to make an investment decision to maximize the firm's future cash flows and its market value. If the manager decides to continue the project from stage n to $n + 1$, it will cause an investment cost for the company.

Competition risk is denoted by the obsolescence rate, which indicates the probability that the future cash flows are extinguished over the next stage. The competition risk is idiosyncratic and therefore does not require a risk premium for itself. Nonetheless, a high obsolescence rate indicates a high probability that future cash flows will become zero. Therefore, the high obsolescence rate lowers the benefits of R&D expenditures and consequently the value of the option to continue the project to the next stage. In the end, the obsolescence rate indirectly affects the firm's systematic risk because it affects the company's decision whether they continue with the project or suspend it.

Companies that operate in competitive markets, often find themselves competing against their rivals in innovation races to develop new technology or product. The winner of this race often takes the market share to itself. Other firms in the industry have to then either suspend or abandon their projects and therefore face zero future cash flows. When compared to concentrated industries, firms can launch their innovation projects with less fear when of obsolescence since there are fewer competitors. Therefore, the obsolescence rate is often higher for firms operating in competitive industries.

Hypothesis 1: Positive relation between R&D investment level and stock return is stronger in competitive industries

The firm has to make an investment decision at any stage before completing the project. Firms also have certain thresholds for their future cash flows and if this cash flow target is not exceeded, the firm will suspend its R&D project. A higher threshold means that the project is riskier since the probability that the project is abandoned or suspended increases if an adverse shock to the potential cash flow occurs. Thus, the company's investment decision and its value are more prone to the systematic risk that the future cash flow carries. A higher R&D investment requirement raises the future cash flow threshold since it tends to lower the value of the option to continue the project. In consequence, a higher requirement for R&D investments results in higher risk premiums, and therefore, companies that invest aggressively in R&D tend to have higher expected returns. To conclude, the obsolescence rate is higher in competitive industries and for those companies that invest heavily in R&D. If a firm operates in a competitive industry and has high R&D-intensity, its obsolescence rate is even higher and therefore increases the future cash flow threshold. The first hypothesis is based on this argument.

Hypothesis 2: Positive relation between competition level and stock return is stronger among R&D-intensive companies

As stated on the previous hypothesis, a high obsolescence rate results in a higher probability that future cash flows will be extinguished and therefore decreases the potential benefits of continuing with the R&D project. Thus, companies in industries that have higher obsolescence rates have to pass higher future cash flow thresholds if they want to continue with the project. The outcome is that these companies have higher risk premiums. In other words, companies in more competitive industries have higher expected returns on their stock. As in hypothesis 1, the firms with high R&D investments also have higher expected returns. This joint effect raises the future cash flow threshold. The second hypothesis is based on this argument.

3. Data and methodology

3.1. Data

The data includes listed and delisted stocks from developed European countries. The list of countries is based on K. French's data library[2] (see table 1). Companies' monthly stock returns from 1991 to 2019 and yearly accounting information from 1989 to 2017 are collected from Thompson Reuters Datastream. I follow Hou and Robinson (2006), and divide firms into different industries according to their Standard Industrial Classification (SIC) code from Datastream. Firms with SIC codes between 6000 and 6799 (financial firms) are excluded from the dataset due to the regulation in these industries. I use three-digit SIC codes since four-digit industry classification results in statistically unreliable portfolios, but on the other hand, two-digit classification groups different businesses together. Original sample included 5848 companies and after excluding financial firms and firms without SIC code, the final sample size is 4350 companies.

I follow Fama and French (1992) to make sure accounting information is already included in firms' stock returns. I match accounting information for all fiscal year-ends in calendar year t – 1 with Datastream stock returns from July of year t to June of year t + 1. Therefore, a minimum gap of six months exists between the stock return and fiscal year-end, which ensures enough time for accounting information to be included in stock returns. However, the time gap differs between firms' accounting information and matching stock return due to different fiscal year-ends.

In this paper, firms' R&D intensity is measured by R&D investment divided by market equity (RD/ME) following to Hou, Xue, and Zhang (2015). They show that only RD/ME can forecast returns and other measures of R&D intensity, for example, RD/Sales, fail to generate significant returns on US stocks. Their findings highlight the need to understand this R&D-to-market anomaly better. Thus, measuring R&D intensity in this paper is more meaningful by using RD/ME. Firms without R&D data are excluded from R&D intensity calculations. The final sample size includes 1957 companies.

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[2] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_5developed.html

Table 1. Following K. French's data library, the table shows the list of countries that are included in the sample. The original sample includes all listed and delisted stocks from 1989 to 2019. The next column shows all the companies that have the Standard Industrial Classification (SIC) code and are not financial firms. The final sample includes all the firms that have available R&D data.

Coutry of exchange	Original sample	Firms with SIC codes 6000-6799 or without SIC code excluded	Final sample: Firms with available R&D data
Austria	62	46	31
Belgium	134	89	48
Denmark	150	105	49
Finland	150	130	81
France	730	621	292
Germany	766	578	322
Greece	176	155	84
Ireland	29	22	12
Italy	316	246	85
Netherlands	113	84	45
Norway	237	181	67
Portugal	52	45	10
Spain	210	138	41
Sweden	665	578	178
Switzerland	244	161	104
United Kingdom	1814	1171	508
Total	5848	4350	1957

Competitiveness in each industry is measured by the Herfindahl-Hirschman Index (HHI), which is used in several papers (see eg. Cetorelli and Strahan (2006) Giroud and Mueller (2011) and Sheen (2014)). The Index gives values for each industry between zero and 10,000, and smaller value means more competition. The HHI is calculated by squaring the market share of each individual firm competing in the industry and then summing all the results together:

$$HHI_{jt} = \sum_{i=1}^{N_j} s_{ijt}^2 \tag{1}$$

where HHI_{jt} is the Herfindahl Index of industry j in year t, N_j is the number of firms in industry j in year t, and s_{ijt} is the market share of firm i in industry j in year t. The market share for each company is calculated by using the firm's net sales divided by the total sales of the whole industry. Companies' asset or equity values could be used instead of net sales. Following Gu (2016), these values produce similar results. Firms with missing sales value are excluded from the sample to calculate the Herfindahl Index for each industry. The index is calculated each year and I use the average value of past two years to prevent possible data errors.

Table 2. Values of the Herfindahl-Hirschman Index (HHI) for every year.

Year	Min	Median	Max	Top 30% breakpoint	Bottom 30% breakpoint	Most competitive industry
1990	1495.4	5385.2	10000	3033.8	5501.4	Grocery stores
1991	1529.2	5291.1	10000	2867.5	5339.2	Grocery stores
1992	1295.4	5307.7	10000	2722.1	5189.0	Motor vehicles
1993	1534.9	5349.3	10000	2657.4	5060.1	Electric services
1994	1396.1	5337.6	10000	2467.9	5002.1	Electric services
1995	1183.5	5323.1	10000	2425.3	5000.1	Computer services
1996	1035.2	5351.3	10000	2068.3	4955.4	Computer services
1997	929.7	5244.2	10000	1725.0	4891.2	Computer services
1998	852.5	5271.6	10000	1662.3	4632.8	Computer services
1999	762.3	5309.5	10000	1511.7	4662.6	Computer services
2000	701.4	5442.6	10000	1520.4	3834.2	Computer services
2001	703.4	5264.4	10000	1455.1	3700.6	Computer services
2002	648.9	5241.8	10000	1399.4	3777.0	Computer services
2003	585.7	5295.2	10000	1318.7	3541.8	Computer services
2004	568.3	5156.6	10000	1265.5	3505.7	Computer services
2005	571.9	5095.9	10000	1279.9	3512.4	Computer services
2006	550.1	5139.7	10000	1335.0	3393.6	Computer services
2007	518.6	5084.4	10000	1237.1	3380.5	Computer services
2008	499.1	5002.9	10000	1204.2	3336.4	Computer services
2009	478.6	4973.2	10000	1165.2	3315.6	Computer services
2010	475.4	4846.5	10000	1181.8	3268.6	Computer services
2011	494.0	4866.3	10000	1177.6	3280.9	Computer services
2012	512.7	4797.5	10000	1156.0	3105.4	Computer services
2013	512.5	4841.6	10000	1140.6	2937.8	Computer services
2014	497.0	4730.1	10000	1131.0	2753.9	Computer services
2015	494.8	4864.6	10000	1112.6	2561.5	Computer services
2016	498.1	4861.6	10000	1098.4	2482.3	Computer services
2017	486.9	4897.1	10000	1097.2	2430.7	Computer services

3.2. Methodology

In this subsection, I demonstrate how the portfolios are built. I use a double-sorting approach where in June of each year t, all stocks are divided into three different classes based on the breakpoints for the bottom 30% (low HHI), middle 40% (medium HHI), and top 30% (high HHI) according to their Herfindahl Index in year t - 1. Then, for all three classes, companies with non-missing R&D value are individually divided into three groups based on the breakpoints for the bottom 30%, middle 40%, and top 30% of RD/ME values from the year t – 1[3]. From these, I form nine different portfolios regarding to the R&D intensity and degree of competition.

First, I construct portfolios by using all companies and their equally weighted returns to show my empirical findings. This might create unreliable results because of small size companies. Due to their

[3] Following Gu (2016), These breakpoints could be sorted by quintile breakpoints that give similar results.

small size, microcap firms usually have rather high RD/ME value when compared to larger firms and therefore they are assigned to R&D-intensive groups. This could affect the interpretation of the returns on the R&D-intensive portfolios. To minimize the effect of the microcap companies, I follow Hou, Xue, and Zhang (2015) to calculate my findings. For the second part, I exclude the smallest 20%, based on the market value, each year and then use equally weighted returns. I call these two different construction methods "all stocks" and "small-cap stocks excluded".

The nine portfolios for both, all stocks and small-cap stocks excluded, are calculated from July of year t to June of next year, t – 1. Portfolios are rebalanced every June. To calculate returns, I use the Fama-French three-factor model, Carhart four-factor model, and Fama-French five-factor model. Model specifications that I estimate:

$$R_t = \alpha + \beta_1 * MKT_t + \beta_2 * SMB_t + \beta_3 * HML_t + \varepsilon_t \quad (2)$$

$$R_t = \alpha + \beta_1 * MKT_t + \beta_2 * SMB_t + \beta_3 * HML_t + \beta_4 * UMD_t + \varepsilon_t \quad (3)$$

$$R_t = \alpha + \beta_1 * MKT_t + \beta_2 * SMB_t + \beta_3 * HML_t + \beta_4 * RMW_t + \beta_5 * CMA_t + \varepsilon_t \quad (4)$$

where R_t is the portfolio's monthly excess return and MKT_t is the value-weighted market return minus the risk-free rate in month *t*. In the Fama-French three-factor model, SMB_t, and HML_t are the month *t* size factor and book-to-market factor. In the Carhart four-factor model, UMD_t is the month *t* momentum factor. In the Fama-French five-factor model, RMW_t, and CMA_t are the month *t* profitability factor and investment factor. All the factors are downloaded from the Kenneth R. French's data library[4].

4. Results

In this part, I investigate and show my empirical findings of the joint effect between R&D investment and market competition.

[4] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#International

4.1. Relation between R&D-intensity and stock return in competitive and concentrated industries

Table 3 shows monthly raw return and abnormal return (i.e., alpha in the pricing model) for each portfolio in concentrated (top 30% of the HHI) and competitive (bottom 30% of the HHI) industries. In Panel A, I use all the stock and their equal-weighted return. In Panel B, I exclude small-cap firms that are below 20% based on the market value and then use all remaining stocks and their equal-weighted return.

Table 3. Research and development investments -return in competitive and concentrated industries. This table shows each portfolio's monthly raw return and abnormal return (α, in per cents). Stocks that are used, are exchanged in developed European countries. The list of countries is based on Kenneth R. French's data library. Portfolios are sorted on industry competition and R&D intensity. Industry competition is measured by the Herfindahl-Hirschman Index (HHI) (See section 3 for definition). Each firm's industry is determined by the three-digit Standard Industrial Classification (SIC) code. R&D intensity is calculated by dividing R&D investment with market equity (RD/ME). All stocks are allocated into three groups based on their HHI-values in year t - 1, using breakpoints for the top 30% (low HHI), middle 40% (medium HHI) and bottom 30% (high HHI). Then, in all groups, firms are individually divided into three subgroups based on their RD/ME value in year t – 1 and using breakpoints for top 30%, middle 40% and bottom 30%. Monthly returns for formed portfolios are then calculated from July year t to June year t + 1 and portfolios are rebalanced after every June. The premium column shows the difference between H-L portfolios of Low HHI and High HHI groups. Monthly abnormal returns of portfolios are computed by time-series regression of excess returns on factors in Fama and French (1992, 2015) three- and five-factor models and in Carhart (1997) four-factor model. In Panel A, I use all the stocks and their equally weighted returns. In Panel B, I exclude small-cap stocks, which are below 20% based on market value and then use all remaining stocks and their equal-weighted return. The sample period is from July 1991 to June 2019. The t-statistics are noted below monthly abnormal returns in parenthesis. The significance levels for 1%, 5% and 10% are shown by ***, ** and *, respectively.

	Low competition (High HHI)				High competition (Low HHI)				
	R&D $_H$	***R&D*** $_M$	***R&D*** $_L$	**H - L**	***R&D*** $_H$	***R&D*** $_M$	***R&D*** $_L$	**H - L**	**Premium**
Panel A: All stocks									
Raw return	1.31***	0.78***	0.65**	0.66***	1.51***	0.91***	0.53*	0.98***	0.32
	(3.99)	(2.64)	(2.28)	(3.45)	(4.42)	(2.79)	(1.67)	(4.92)	(1.40)
Fama-French three-factor	0.44***	-0.05	-0.14	0.58***	0.63***	0.09	-0.22	0.95***	0.27
	(2.72)	(0.43)	(1.05)	(3.03)	(3.65)	(0.65)	(1.50)	(4.47)	(1.22)
Carhart four-factor	0.60***	0.11	0.08	0.52**	0.72***	0.25*	0.04	0.68***	0.16
	(3.61)	(0.92)	(0.59)	(2.57)	(3.99)	(1.68)	(0.28)	(3.42)	(0.68)
Fama-French five-factor	0.50***	-0.13	-0.08	0.58***	0.84***	0.35**	-0.06	0.90***	0.31
	(2.90)	(1.08)	(0.53)	(2.82)	(4.58)	(2.28)	(0.35)	(4.36)	(1.32)
Panel B: Small-cap stocks excluded									
Raw return	0.97***	0.77***	0.47*	0.50***	1.26***	0.77**	0.44	0.82***	0.32
	(2.87)	(2.59)	(1.66)	(3.01)	(3.65)	(2.33)	(1.39)	(4.09)	(1.59)
Fama-French three-factor	0.04	-0.07	-0.33***	0.37**	0.35**	-0.06	-0.30**	0.65***	0.28
	(0.28)	(0.58)	(2.72)	(2.33)	(2.08)	(0.44)	(2.02)	(3.41)	(1.42)
Carhart four-factor	0.26*	0.07	-0.15	0.41**	0.50***	0.16	-0.04	0.54***	0.12
	(1.80)	(0.61)	(1.22)	(2.46)	(2.86)	(1.08)	(0.25)	(2.67)	(0.60)
Fama-French five-factor	0.12	-0.14	-0.36***	0.48***	0.53***	0.20	-0.12	0.65***	0.17
	(0.76)	(1.21)	(2.73)	(2.78)	(2.96)	(1.32)	(0.73)	(3.13)	(0.79)

Panel A includes the small-cap stocks which are often placed in high-intensity R&D portfolios in both competitive and concentrated industries. The returns on these two portfolios according to all three asset-pricing models are positive and highly significant which do not support the prior studies that in low competition group R&D-intensive firms do not generate abnormal returns. Panel A still supports the hypothesis that positive R&D-return relation is stronger in competitive industries.

As regards to my findings, first, the raw return on the high-minus-low portfolio is highly significant in competitive and as well in concentrated industries. This is shown in both panels and the monthly return difference between the two groups is highlighted in the premium column in the table. In both panels, the raw returns gradually increase when the level of R&D increases. From the panels, we can see that in competitive industries the premium for the high-minus-low portfolio is larger and more significant. In Panel A, the monthly raw return for the high-minus-low portfolio in competitive industries is 0.98% with a t-statistic of 4.92. The corresponding values in concentrated industries are 0.66% per month and the t-statistic of 3.45. In the Panel B, the monthly raw return for the high-minus-low portfolio in competitive industries is 0.82% with 4.09 t-statistic. In contrast, the return in concentered industries is 0.5% with 3.01 t-statistic.

Second, as shown in the Panels, abnormal returns increase gradually in low competition as well as in high competition industries. For instance, in Panel B, the Fama-French three-factor model for competitive industries for high, medium and low R&D-portfolios shows monthly alphas of 0.35%, -0.06% and -0.30% with t-statistics 2.08, 0.44 and 2.02, respectively. The high-minus-low alpha is 0.65%, with a t-statistic of 3.41, which returns 7.80% annually. For concentrated industries, these values are 0.04%, -0.07% and -0.33% with t-statistics 0.28, 0.58 and 2.72, respectively. The high-minus-low alpha is 0.37%, with a t-statistic of 2.33, which translates to a yearly return of 4.44%. This is in line with previous cites that R&D investments are one of the most important drivers that affect the firm's stock return and companies that invest more will generate higher returns. However, only in competitive industries, firms that invest aggressively in R&D can generate high significant abnormal returns. This can be seen from all three asset pricing models that return monthly alphas of 0.35%, 0.50% and 0.53% with t-statistics of 2.08, 2.86 and 2.96, respectively. In contrast, the corresponding estimates in concentrated industries are 0.04%, 0.26% and 0.12% with t-statistics of 0.28, 1.80 and 0.76, respectively. Portfolios that include companies with a low contribution in R&D return negative alphas in both, competitive and concentrated industries. The negative return is higher in concentrated industries. Fama-French three-factor, Carhart four-factor and Fama-French five-factor monthly alphas for low R&D portfolio in concentrated industries are -0.33%, -0.15% and -0.36% with t-statistics of 2.72, 1.22 and 2.73, respectively. The corresponding values in competitive industries are -0.30%, -0.04% and -0.12% with t-statistics of 2.02, 0.25 and 0.73, respectively.

In Panel A for R&D-intensive portfolio in concentrated industries generates significant monthly abnormal returns. This is not in line with prior studies and not seen in Panel B, therefore it can be due to small-cap firms. Nonetheless, when analyzing both panels, the monthly returns and the t-statistics for the high-minus-low portfolio are significant at the 1% level for all three asset-pricing models in competitive industries. Compared to concentrated industries, only the Fama-French five-factor model in Panel B gives a t-statistic at 1% significance level and two other models report significance levels at 5%.

To conclude, the results in Table 3 support the hypothesis that the positive relation between R&D investments and stock return is stronger in competitive industries than in concentrated industries. The return premium decreases for R&D-intensive firms that operate in concentrated industries. This is shown by high-minus-low portfolios. The results suggest that earlier cites about positive relation between R&D investments and stock returns are a combination of firms operating in industries with different degrees of competition. This positive joint relation is mainly driven by companies in competitive industries. In addition, aggressive investing in R&D usually affects a firm's risk profile and its expected returns. The results suggest that these effects can be very different between firms that have the same degree of R&D intensity but are operating in industries with different levels of competitiveness. For example, in Panel B, firms that aggressively invest in R&D are able to generate abnormal returns only in competitive industries Thus, the level of competition explains a significant portion of the positive relation between R&D and returns. Finally, the findings suggest that no matter the level of competitiveness, firms have to invest in R&D, or they will likely generate negative abnormal returns.

4.2. Relation between competition level and stock return among R&D-intensive firms

In this section, I test the second hypothesis that the positive relation between competition level and stock return is stronger among R&D-intensive firms than with firms that invest only a little on R&D. In Table 4, portfolios are grouped into two different groups based on the intensiveness of their R&D expenditures. Low R&D intensity group includes the firms, which are in the bottom 30%, and high

R&D intensity group contains companies that are in the top 30% according to their RD/ME-value. In Panel A, I use all the stock and their equally weighted return. In Panel B, I exclude small-cap firms that are below 20% based on market value and then use all remaining stocks and their equally weighted return.

Table 4. Research and development investments -return in competitive and concentrated industries. This table shows each portfolio's monthly raw return and abnormal return (α, in per cents). Stocks that are used, are exchanged in developed European countries. The list of countries is based on Kenneth R. French's data library. Portfolios are sorted on industry competition and R&D intensity. Industry competition is measured by the Herfindahl-Hirschman Index (HHI) (See section 3 for definition). Each firm's industry is determined by the three-digit Standard Industrial Classification (SIC) code. R&D intensity is calculated by dividing R&D investment with market equity (RD/ME). All stocks are allocated into three groups based on their HHI-values in year t - 1, using breakpoints for the top 30% (low HHI), middle 40% (medium HHI) and bottom 30% (high HHI). Then, in all groups, firms are individually divided into three subgroups based on their RD/ME value in year t – 1 and using breakpoints for top 30%, middle 40% and bottom 30%. Monthly returns for formed portfolios are then calculated from July year t to June year t + 1 and portfolios are rebalanced after every June. The premium column shows the difference between L-H portfolios of High R&D and low R&D groups. Monthly abnormal returns of portfolios are computed by time-series regression of excess returns on factors in Fama and French (1992, 2015) three- and five-factor models and in Carhart (1997) four-factor model. In Panel A, I use all the stocks and their equally weighted returns. In Panel B, I exclude small-cap stocks, which are below 20% based on market value and then use all remaining stocks and their equal-weighted return. The sample period is from July 1991 to June 2019. The t-statistics are noted below monthly abnormal returns in parenthesis. The significance levels for 1%, 5% and 10% are shown by ***, ** and *, respectively.

	Low R&D-intensity				**High R&D-intensity**				
	HHI_L	HHI_M	HHI_H	**L - H**	HHI_L	HHI_M	HHI_H	**L - H**	**Premium**
Panel A: All stocks									
Raw return	0.53*	0.53*	0.65**	-0.12	1.51***	1.34***	1.31***	0.20	0.32
	(1.67)	(1.68)	(2.28)	(0.68)	(4.42)	(3.94)	(3.99)	(1.22)	(1.40)
Fama-French three-factor	-0.22	-0.31**	-0.14	-0.08	0.63***	0.46***	0.44***	0.19	0.27
	(1.50)	(2.17)	(1.05)	(0.51)	(3.65)	(2.74)	(2.72)	(1.14)	(1.22)
Carhart four-factor	0.04	-0.04	0.08	-0.04	0.72***	0.64***	0.60***	0.12	0.16
	(0.28)	(0.26)	(0.59)	(0.24)	(3.99)	(3.66)	(3.61)	(0.67)	(0.68)
Fama-French five-factor	-0.06	-0.21	-0.08	0.02	0.84***	0.71***	0.50***	0.34*	0.31
	(0.35)	(1.42)	(0.53)	(0.13)	(4.58)	(3.95)	(2.90)	(1.87)	(1.32)
Panel B: Small-cap stocks excluded									
Raw return	0.44	0.57*	0.47*	-0.03	1.26***	1.01***	0.97***	0.29**	0.32
	(1.39)	(1.74)	(1.66)	(0.21)	(3.65)	(3.04)	(2.87)	(2.01)	(1.59)
Fama-French three-factor	-0.30**	-0.29*	-0.33***	0.03	0.35**	0.12	0.04	0.31**	0.28
	(2.02)	(1.89)	(2.72)	(0.22)	(2.08)	(0.83)	(0.28)	(2.13)	(1.42)
Carhart four-factor	-0.04	0.01	-0.15	0.11	0.50***	0.32**	0.26*	0.24	0.12
	(0.25)	(0.10)	(1.22)	(0.75)	(2.86)	(2.20)	(1.80)	(1.55)	(0.60)
Fama-French five-factor	-0.12	-0.20	-0.36***	0.25	0.53***	0.31**	0.12	0.41***	0.17
	(0.73)	(1.21)	(2.73)	(1.62)	(2.96)	(2.00)	(0.76)	(2.64)	(0.79)

First, when analyzing raw returns in Panel B, the results show that the monthly return on the high-minus-low competition portfolio is positive and insignificant in the low R&D-intensive group. In contrast, the return for the high R&D-intensive group is positive and significant. The monthly return on the high-minus-low competition portfolio for a low R&D-intensity group is -0.03% with a t-statistic of 0.21. The comparable result for the high R&D-intensive group is monthly return of 0.29%

and it is statistically significant at the 5% level. In addition, the similar monthly returns on high-minus-low competition portfolios are also seen on the Panel A. Even though the estimates are not significant, they strengthen the proposition that the level of competitiveness is a major factor among R&D-intensive firms. The monthly return difference between the two groups is highlighted in the premium column in the table.

Second, Panel B shows that companies in more competitive industries earn higher abnormal returns during the sample period, but these excess returns are only seen among R&D-intensive firms. The abnormal returns on high-minus-low competition portfolios are small or even negative on for companies in the low R&D intensity group. This finding is shown in all three asset pricing models. For example, in Panel B and low R&D intensity group, the abnormal monthly returns for high, medium and low competition portfolios according to the three-factor model are -0.30%, -0.29% and -0.33% with t-statistics of 2.02, 1.89 and 2.72, respectively. The return on the high-minus-low competition portfolio is 0.03% with a t-statistic of 0.22. In contrast, the same abnormal monthly returns in R&D-intensive group are 0.35%, 0.12% and 0.04% with t-statistics of 2.08, 0.83 and 0.28 respectively. The return on high-minus-low competition portfolio is 0.31% per month with t-statistic of 2.31, which returns in 3.72% yearly premium. The similar results are also shown in both groups according to four- and five-factor models. In the low R&D intensity group, the Carhart four-factor model does not show any significant abnormal returns and monthly returns are small or negative for all three competition portfolios. The monthly return on the high-minus-low competition portfolio is 0.11% with a t-statistic of 0.75. In contrast, the corresponding returns in high R&D intensity group are 0.50%, 0.32% and 0.26% with t-statistics of 2.86, 2.20 and 1.80, respectively. The monthly return on the high-minus-low competition portfolio is 0.24% with a t-statistic of 1.55. The high-minus-low competition portfolio return according to the five-factor model is 0.25% per month among the low R&D-intensity group and 0.41% for the high R&D-intensity group. The t-statistics are 1.62 and 2.64, respectively.

Similar results are also reported when including microcap firms in the sample. Panel A shows the returns on the high-minus-low competition portfolio in the low R&D intensity group. Three-, four- and five-factor models report the monthly returns of -0.08%, -0.04% and 0.02%, respectively. The t-statistics for the returns are 0.51, 0.24 and 0.13. The corresponding results for high R&D intensity group are 0.19%, 0.12% and 0.34% with t-statistics of 1.14, 0.67 and 1.87. In conclusion, the results in Table 2 support the second hypothesis that competition premium is stronger among R&D-intensive

firms. This is mainly shown in high-minus-low competition portfolios, which have higher premiums among high R&D intensive group.

5. Robustness test

The results shown in the previous sector show some robustness since I use three different asset-pricing models that report similar results between them. In addition, both ways of creating the portfolio give compatible end results, even though the panel with all the firms is biased due to its way of including small-cap stocks to the high R&D portfolios. The gradual increasing from low R&D-intensity to high R&D-intensity is shown on both panels, and the increase is higher among highly competitive industries. In this sector, I perform a robustness test with an alternative way of dividing firms into competitive and concentrated industries. In the last paragraph, I also report the results from my other findings and use previous literature from this topic to show the robustness of my results.

To perform a robustness test, I use the concentration ratio instead of the Herfindahl-Hirschman Index. The ratio has been used by many researchers for a long time. For example, Bain (1951) as well as Hall and Tideman (1967), use it in their papers. The concentration ratio (CR) is known to be the simplest way to calculate the concentration of the industry. The CR reports the combined market share of the desired amount q of the largest firms in a market, which is then divided by the whole market size:

$$CR_{qt}^{s} = \sum_{i=1}^{q} MS_{it}^{s} \tag{5}$$

In the equation, *q* is a number of the largest firms that are included to the sample. Typically, *q* is set to three, four or five. In turn, *MS* is the market share of a firm *i*, in industry *s*, during year *t*. Market share is calculated as before by net sales of a firm. The CR only takes in to account the market share of the largest *q* firms in the industry and ignores the distribution among the other firms, thus giving different values than HHI. In addition, problems can arise with CR since it fails to capture the effects if there are only a few companies operating in the industry or if there are several firms with small market shares. Therefore, using HHI as my primary concentration measure is justified.

In this test, I follow Cavalleri, Eliet, McAdam, Petroulakis, Soares, and Vansteenkiste (2019), and use q value of four. I use the same double-sorting approach as in sector 3 but replace the HHI-value of an industry with CR-value. I exclude the 20% of the smallest stocks to eliminate the small-cap stock bias on high R&D-intensity portfolios. Finally, due to data limitations, the sample period is from July 2000 to June 2019, but this can be used as a robustness test since this same sample period for HHI generates similar values as the period of 1991-2019.

Table 5. Research and development investments -return in competitive and concentrated industries. This table shows each portfolio's monthly raw return and abnormal return (α, in per cents). Stocks that are used, are exchanged in developed European countries. The list of countries is based on Kenneth R. French's data library. Portfolios are sorted on industry competition and R&D intensity. Industry competition is measured by concentration ratio (CR). Each firm's industry is determined by the three-digit Standard Industrial Classification (SIC) code. R&D intensity is calculated by dividing R&D investment with market equity (RD/ME). All stocks are allocated into three groups based on their CR-values in year *t* - 1, using breakpoints for the top 30% (low CR), middle 40% (medium CR) and bottom 30% (high CR). Then, in all groups, firms are individually divided into three subgroups based on their RD/ME value in year *t* – 1 and using breakpoints for top 30%, middle 40% and bottom 30%. Monthly returns for formed portfolios are then calculated from July year *t* to June year *t* + 1 and portfolios are rebalanced after every June. The premium column shows the difference between H-L portfolios of Low HHI and High HHI groups. Monthly abnormal returns of portfolios are computed by time-series regression of excess returns on factors in Fama and French (1992, 2015) three- and five-factor models and in Carhart (1997) four-factor model. I exclude small-cap stocks, which are below 20% based on market value and then use all remaining stocks and their equally weighted return. The sample period is from July 1991 to June 2019. The *t*-statistics are noted below monthly abnormal returns in parenthesis. The significance levels for 1%, 5% and 10% are shown by ***, ** and *, respectively.

	Low competition (High CR)				**High competition (Low CR)**				
	$R\&D_H$	$R\&D_M$	$R\&D_L$	**H - L**	$R\&D_H$	$R\&D_M$	$R\&D_L$	**H - L**	**Premium**
Raw return	0.87*	0.65*	0.26	0.61***	1.08**	0.52	0.17	0.91***	0.30
	(1.94)	(1.68)	(0.70)	(3.43)	(2.50)	(1.16)	(0.39)	(4.33)	(1.36)
Fama-French three-factor	0.09	0.00	-0.38***	0.48***	0.39**	-0.08	-0.37**	0.76***	0.29
	(0.54)	(0.01)	(3.01)	(2.82)	(2.12)	(0.40)	(2.04)	(3.70)	(1.36)
Carhart four-factor	0.34**	0.12	-0.22*	0.55***	0.57***	0.19	0.12	0.69***	0.14
	(2.02)	(0.87)	(1.74)	(3.18)	(3.09)	(1.07)	(0.67)	(3.26)	(0.65)
Fama-French five-factor	0.26	-0.01	0.31**	0.57***	0.62***	0.38**	0.01	0.61***	0.04
	(1.46)	(0.06)	(2.30)	(3.32)	(3.22)	(2.07)	(0.05)	(2.94)	(0.17)

Table 5 shows corresponding values to Table 3 for Panel B that excludes small-cap firms. The results are similar, and it shows the gradual increase in both, high CR and low CR groups. However, the premium for R&D-intensive firms is higher among low CR group and this same pattern is seen on Table 3 and Panel B. The difference between the two groups is highlighted in the premium column in the table. For example, the high-minus-low R&D-intensity portfolio in the low CR group reports raw monthly returns of 0.91% with a t-statistic of 4.33. In contrast, the corresponding value for the high CR group is 0.61% with a t-statistic of 3.43. The same effect is seen with all three asset-pricing models that report higher abnormal returns and t-statistics for R&D-intensive portfolio as well as for the high-minus-low R&D-intensity portfolio.

Table 6 reports corresponding values to Table 4 and Panel B. The results show similar returns, even though they are slightly lower with smaller t-statistics. The competition premium is higher among the high R&D-intensity group than it is for low R&D-intensity group. The difference between the two groups is highlighted in the premium column in the table. For example, the raw monthly return for low-minus-high CR portfolio in high R&D-intensity group is 0.21% with a t-statistic of 1.33. The corresponding value for the low R&D-intensity group is -0.09% with 0.52 t-statistic. The same pattern is shown by all three asset-pricing models, even though the Fama-French five-factor model gives a larger t-statistic for low-minus-high CR portfolio.

Table 6. Research and development investments -return in competitive and concentrated industries. This table shows each portfolio's monthly raw return and abnormal return (α, in per cents). Stocks that are used, are exchanged in developed European countries. The list of countries is based on Kenneth R. French's data library. Portfolios are sorted on industry competition and R&D intensity. Industry competition is measured concentration ratio (CR). Each firm's industry is determined by the three-digit Standard Industrial Classification (SIC) code. R&D intensity is calculated by dividing R&D investment with market equity (RD/ME). All stocks are allocated into three groups based on their CR-values in year *t* - 1, using breakpoints for the top 30% (low CR), middle 40% (medium CR) and bottom 30% (high CR). Then, in all groups, firms are individually divided into three subgroups based on their RD/ME value in year *t* – 1 and using breakpoints for top 30%, middle 40% and bottom 30%. Monthly returns for formed portfolios are then calculated from July year *t* to June year *t* + 1 and portfolios are rebalanced after every June. The premium column shows the difference between L-H portfolios of High R&D and low R&D groups. Monthly abnormal returns of portfolios are computed by time-series regression of excess returns on factors in Fama and French (1992, 2015) three- and five-factor models and in Carhart (1997) four-factor model. I exclude small-cap stocks, which are below 20% based on market value and then use all remaining stocks and their equally weighted return. The sample period is from July 1991 to June 2019. The *t*-statistics are noted below monthly abnormal returns in parenthesis. The significance levels for 1%, 5% and 10% are shown by ***, ** and *, respectively.

	Low R&D-intensity				High R&D-intensity				
	CR_L	CR_M	CR_H	L - H	CR_L	CR_M	CR_H	L - H	Premium
Raw return	0.17	0.43	0.26	-0.09	1.08**	0.95**	0.87*	0.21	0.30
	(0.39)	(1.06)	(0.70)	(0.52)	(2.50)	(2.18)	(1.94)	(1.33)	(1.36)
Fama-French three-factor	-0.37**	-0.21	-0.38***	0.01	0.39**	0.25	0.05	0.30**	0.29
	(2.04)	(1.19)	(3.01)	(0.08)	(2.12)	(1.42)	(0.54)	(1.96)	(1.36)
Carhart four-factor	-0.12	0.01	-0.22*	0.10	0.57***	0.40**	0.34**	0.24	0.14
	(0.67)	(0.09)	(1.74)	(0.60)	(3.09)	(2.19)	(2.02)	(1.50)	(0.65)
Fama-French five-factor	-0.01	0.06	-0.31**	0.32**	0.62***	0.43**	0.26	0.36**	0.04
	(0.05)	(0.32)	(2.30)	(2.00)	(3.22)	(2.29)	(1.46)	(2.18)	(0.17)

I also created portfolios including all stocks and their value-weighted returns. This table shows similar results when it comes to the monthly returns. However, concluding the table on this paper is not relevant, since the t-statistics on this table are mainly insignificant but it also shows the return premium for the high-minus-low R&D-intensity portfolio in the competitive industries group. In addition, Hoberg and Phillips (2010) show an alternative Herfindahl-Hirschman Index that considers private firms. They show that using both, public and private firms, to calculate the index, does not make major changes to the HHI values. Finally, Gu (2016) tests if the financial constraint or innovation ability of a firm affects the return premium for firms with high R&D-intensity in competitive industries. The innovation ability is measured by the average of the coefficient from the regression of sales on the previous five-year investments in R&D by following Cohen, Diether and Malloy (2013). Financial constraint is based on WW index by Whited and Wu (2006). The outcome was that these measures do not affect the results, thus making findings in this paper more robust.

6. Conclusion

In this paper, I have examined the joint effect between R&D investments and industry competition level on stock returns in developed European countries from 1991 to 2019. The results give new perspectives on the positive R&D-return relation as well as on the competition-return relation that have been studied quite a lot by researchers. In more competitive industries, firms compete against their rivals and frequently enter in innovation races. Since the winner of the race often takes the market share for itself, the other companies have to suspend or even abandon their R&D projects. This makes the potential future cash flows more uncertain in competitive industries. Thus, R&D-intensive firms are exposed to more systematic risk, especially in competitive industries.

My findings support these insights and show that the positive return premium between high R&D intensity portfolio and low R&D intensity portfolio is larger among competitive industries than in concentrated industries. I also find that competition-return relation exists mainly among R&D-intensive companies. Low R&D intensity companies do not generate higher returns in a more competitive environment but R&D-intensive firms show gradually increasing returns when competitiveness increases. I have tested the method with an alternative way to calculate the competitiveness level of an industry, which reported similar results. I also tested my hypothesis in two different ways by first including and then excluding small-cap stocks. I then showed the results on three different asset-pricing models to show robustness on my findings.

To conclude, the findings suggest that competition level is a key factor among R&D-intensive firms. It affects the firms' risk and return profiles, and thus explains a significant part of the R&D premium that has been discovered in prior studies. This paper leaves the potential to the future to examine why the relation between R&D-intensity and industry competition is stronger among the U.S. companies and why R&D-intensive firms in Europe generate positive abnormal returns also in concentrated industries but in the U.S., they give very small or negative excess returns.

7. References

Aguerrevere, F.L., 2009. Real options, product market competition, and asset returns. Journal of Finance 64, 957–983.

Bain, J., 1951. Relation of profit rate to industry concentration: American manufacturing, 1936-1940. The Quarterly Journal of Economics 65, 293-324.

Bena, J., Garlappi, L., 2011. Strategic investments, technological uncertainty, and expected return externalities. Published working paper. University of British Columbia, Vancouver, British Columbia, Canada.

Berk, J.B., Green, R.C., Naik, V., 2004. Valuation and return dynamics of new ventures. Review of Financial Studies 17, 1–35.

Carhart, M.M., 1997. On persistence in mutual fund performance. Journal of Finance 52, 57–82.

Cavalleri, M., Eliet, A., McAdam, P., Petroulakis, F., Soares, A., Vansteenkiste, I., 2019. Concentration, market power and dynamism in the euro area. Working Paper Series by European Central bank, No 2253.

Cetorelli, N., Strahan, P., 2006. Finance as a barrier to entry: bank competition and industry structure in local U.S. markets. The Journal of Finance 61, 437-461.

Chambers, D., Jennings, R., Thompson, R.B., 2002. Excess returns to R&D-intensive firms. Review of Accounting Studies 7,133-158.

Chan, L.K.C., Lakonishok, J., Sougiannis, T., 2001. The stock market valuation of research and development expenditures. Journal of Finance 56, 2431–2456.

Chan, S. H., Martin, J., Kensinger, J., 1990. Corporate research and development expenditures and share value. Journal of Financial Economics 26, 255-276.

Cohen, L., Diether, K., Malloy, C., 2013. Misvaluing innovation. Review of Financial Studies 26, 635-666.

Eberhart, A.C., Maxwell, W.F., Siddique, A.R., 2004. An examination of long-term abnormal stock returns and operating performance following R&D increases. Journal of Finance 59,623–650.

Fama, E., French, K., 1992. The cross-section of expected stock returns. The journal of Finance 47, 427-465.

Fama, E., French, K., 2015. A five-factor asset pricing model. Journal of Financial Economics 116, 1–22.

Giroud, X., Mueller, H., 2011. Corporate governance, product market competition, and equity prices. The journal of Finance 66, 563-600.

Gu, L., 2016. Product market competition, R&D investment, and stock returns. Journal of Financial Economics 119, 441-455.

Hall, M., Tideman, N., 1967. Measures of concentration. Journal of the American Statistical Association 62, 162-168.

Hirshleifer, D., Hsu, P.-H., Li, D., 2013. Innovative efficiency and stock returns. Journal of Financial Economics 107, 632–654.

Hoberg, G., Phillips, G., 2010. Real and financial industry booms and busts. Journal of Finance 65,45–86.

Hou, K., Robinson, D.T., 2006. Industry concentration and average stock returns. Journal of Finance 61, 1927–1956.

Hou, K., Xue, C., Zhang, L., 2015. Digesting anomalies: an investment approach. Review of Financial Studies 28, 650–705.

Hsu, P.-H., 2009. Technological innovations and aggregate risk premiums. Journal of Financial Economics 94, 264–279.

Lev, B., Sarath, B., Sougiannis, T., 2000. R&D reporting biases and their consequences. Contemporary Accounting Research 22, 977-1026.

Lev, B., Sougiannis, T., 1996. The capitalization, amortization, and value-relevance of R&D. Journal of Accounting and Economics 21, 107–138.

Li, D., 2011. Financial constraints, R&D investment, and stock returns. Review of Financial Studies 24, 2974–3007.

Lin, X., 2012. Endogenous technological progress and the cross section of stock returns. Journal of Financial Economics 103, 411–428.

Penman, S., Zhang, X.-J., 2002. Accounting conservatism, the quality of earnings, and stock returns. The Accounting Review 77, 237-264.

Sheen, A., 2014. The real product market impact of mergers. The journal of Finance 69, 2651-2688.

Whited, T.M., Wu, G., 2006. Financial constraints risk. Review of Financial Studies 19, 531–559.