Journal of Financial Economics 119 (2016) 441–455

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Product market competition, R&D investment, and stock returns☆

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ARTICLE INFO

Article history:
Received 3 December 2014
Received in revised form
30 April 2015
Accepted 4 May 2015
Available online 3 October 2015

JEL classification:
D43
G12
O32

Keywords:
Research and development investment
Product market competition
Risk premium
Stock returns

ABSTRACT

A standard real options model predicts a strong positive interaction effect between research and development (R&D) investment and product market competition. R&D-intensive firms tend to be riskier and earn higher expected returns than R&D-weak firms, particularly in competitive industries. Also, firms in competitive industries earn higher expected returns than firms in concentrated industries, especially among R&D-intensive firms. Intuitively, R&D projects are more likely to fail in the presence of more competition because rival firms could win the innovation race. Empirical evidence largely supports the model's predictions.

1. Introduction

Investment in research and development (R&D) is one of the most important activities driving companies' long-term viability. A substantial portion of firms listed on the US stock market invest aggressively in R&D, and firms in competitive industries frequently enter into innovation races with many rivals. When one firm successfully completes an R&D project before other firms in an innovation race, these other firms often suspend or even abandon similar projects. Suspending or abandoning an R&D project significantly reduces firm value, for doing so prevents projected cash flows associated with the R&D project from being realized, and R&D investment tends to be irreversible. Therefore, competition can have a substantial impact on R&D-intensive firms.

This paper studies the joint effect of product market competition and R&D investment on stock returns. Based on a real options model developed by Berk, Green, and Naik (2004) for a multistage R&D venture, I establish two new testable hypotheses: (1) the positive R&D-return relation is stronger in competitive industries, and (2) the positive competition-return relation is stronger among R&D-intensive firms. In other words, competition and R&D

☆ I am very grateful to Dirk Hackbarth, Tim Johnson, George Pennacchi, and Prachi Deuskar for their guidance, advice, and encouragement. I am also very grateful to William Schwert (the editor) and the anonymous referee for helpful comments that have greatly improved this paper's quality. I thank Frederico Belo for his great discussion in the Western Finance Association (WFA) 2013 meetings. I also thank Heitor Almeida, Jan Bena, Vyacheslav Fos, Lorenzo Garlappi, Po-Hsuan Hsu, Rustom M. Irani, Einar C. Kjenstad, Mathias Kronlund, Dongmei Li, Neil Pearson, Yuri Tserlukevich, Zhi Wang, seminar participants at WFA 2013, and seminar participants at several universities for their helpful comments. Finally, I would like to thank SAC Capital for the PhD Candidate Award for Outstanding Research at WFA 2013, as well as the USC Marshall School of Business for the Trefftzs Award for the best student paper at WFA 2013. All errors are my own.
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http://dx.doi.org/10.1016/j.jfineco.2015.09.008
0304-405X/

investment have a strong positive interaction effect on expected stock returns.

In the model, the firm progresses through the R&D project in sequential stages and decides whether or not to incur an instantaneous R&D investment to continue the project. Prior to completing the project, the decision maker can observe future cash flows that the project would be producing if it were completed today. Because the risk associated with cash flows has a systematic component, this feature imparts a substantial amount of systematic risk to the project, making the R&D venture a series of compound options on systematic uncertainty. Because options have higher systematic risk than the underlying asset due to the implicit leverage in options, the R&D venture demands a higher risk premium than the stochastic cash flow itself.

Competition increases the probability that potential future cash flows will be extinguished and in turn decreases the benefits of R&D investing and raises the chances that the project will be suspended if adverse shocks to future cash flows occur. Therefore, firms' investment decisions and value are more sensitive to the systematic risk associated with these cash flows. Although the risk of competition is idiosyncratic, it raises the exercise threshold for successive R&D investment options, thereby levering the firm's exposure to systematic risk. As an intuitive comparison, in the Black and Scholes model, the elasticity of a call option with respect to the underlying risk is increased as the distance to exercise increases. Moreover, firms with high R&D inputs face even greater negative impacts from extinguished potential cash flows, for these inputs further reduce the value of investment options. Thus, the model predicts a stronger positive relation between competition and expected returns among R&D-intensive firms. Analogously, the model also predicts a stronger positive relation between R&D investment and expected returns for firms in highly competitive industries.

Using a conventional double-sorting approach, I test the model's predictions empirically and show a robust positive interaction effect between product market competition and R&D investment on stock returns. The tests reveal that the positive R&D-return relation exists only in competitive industries. The raw returns and the abnormal returns (i.e., alpha in the asset pricing model) on the double-sorted portfolios increase monotonically with R&D intensity for firms in competitive industries. However, this return pattern does not exist for firms in concentrated industries. This finding holds for all three asset pricing models—the Carhart (1997) four-factor model, the Hou, Xue, and Zhang (2015) q-factor model, and the Fama and French (2015) five-factor model—as well as for both NYSE breakpoints and all-but-micro breakpoints. For instance, when analyzed using all-but-micro breakpoints, the monthly equal-weighted q-factor alphas on the low, medium, and high R&D-intensity portfolios in competitive industries are 0.10%, 0.48%, and 0.77%, respectively, with t-statistics of 0.92, 5.17, and 5.70. Further, the q-factor alpha on the high-minus-low R&D-intensity portfolio is as high as 67 basis points per month and statistically significant at the 1% level. In contrast, the monthly equal-weighted q-factor alphas on the low, medium, and high R&D-intensity portfolios in concentrated industries are much smaller and insignificant: −0.06%, −0.18%, and 0.07%, respectively, with t-statistics of 0.38, 1.24, and 0.34. This translates to a monthly alpha spread of only 0.13% with a t-statistic of 0.56. Moreover, when analyzed using NYSE breakpoints, the value-weighted q-factor alpha on the high-minus-low R&D-intensity portfolio is 50 basis points per month in competitive industries, whereas it is −0.29% in concentrated industries.

I also find that the positive competition-return relation exists only among R&D-intensive firms. The portfolio raw return and abnormal return increase monotonically with the degree of competition among firms with high R&D inputs, but this pattern does not exist among firms with low R&D inputs. This finding is robust for all three asset pricing models, as well as for both NYSE breakpoints and all-but-micro breakpoints. For example, when analyzed using all-but-micro breakpoints, the monthly equal-weighted q-factor alphas on the low, medium, and high competition portfolios among R&D-intensive firms are 0.07%, 0.02%, and 0.77%, respectively, with t-statistics of 0.34, 0.11, and 5.70. Further, the q-factor alpha on the high-minus-low competition portfolio is 0.70% and statistically significant at the 1% level. In contrast, for firms with low R&D inputs, the alphas on the competition portfolios are always small and insignificant. The monthly q-factor alpha on the high-minus-low competition portfolio is −0.14% with a t-statistic of 1.09.

These return patterns also hold under numerous robustness tests, from measuring competition with an alternative industry concentration measure to using different sorting methods or including more factors in the asset pricing model. More important, by performing subsample studies, I verify that my findings are not driven by financial constraints and innovation ability that have been identified by Li (2011) and Cohen, Diether, and Malloy (2013) as factors that affect R&D investment's risk and effectiveness.

This paper has two main contributions. First, it contributes to the literature on the relation between R&D investment 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). Prior studies find positive premiums associated with R&D-intensity measures. Hou, Xue, and Zhang (2014, 2015) show that their q-factor model can capture many anomalies in the cross section but not the R&D-to-market (i.e., R&D expenditure scaled by market equity) anomaly. Thus, a thorough understanding of the R&D anomaly is still lacking, and this gap motivates my work. By accounting for the rival risk associated with R&D projects, I numerically illustrate and empirically show that the positive R&D-return relation is more pronounced for firms in competitive industries. Furthermore, the role of competition cannot be justified by financial constraints and innovation ability, both of which are proposed as explanations for the R&D anomaly. Hence, these pieces of evidence suggest that competition independently drives a significant portion of the positive R&D-return relation.

Second, this paper contributes to the literature on the relation between competition and stock returns (see, e.g., Hou and Robinson, 2006; Aguerrevere, 2009). Hou and Robinson