Corporate R&D and Stock Returns: International Evidence

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Firms with higher R&D intensity subsequently experience higher stock returns in international stock markets, which is consistent with the U.S. evidence and suggests a fundamentally important role of intangible investments in international asset pricing. We find that this positive effect of R&D intensity on stock returns is stronger in countries with higher market value to growth options, but is unrelated to country characteristics representing market sentiment and limits-of-arbitrage. Moreover, we find that R&D-intensive firms are associated with higher market-to-book ratios, higher future return volatility, and higher future profitability. The evidence suggests that the cross-sectional relation between R&D intensity and stock return is more likely attributable to risk associated with innovation than to mispricing or market friction.

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1 Introduction

> Research and development is the major driver of technological change—hence the central role of R&D in economic growth and welfare improvement. The impact of R&D and technological change on economic growth has long been recognized by proponents of free market economies such as Adam Smith, Marshall, Keynes, and Solow. Even two of the most ardent critics of capitalist societies, Marx and Engels, argued in the Communist Manifesto that capitalism depends for its very existence on the constant introduction of new products and processes.
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> – Baruch Lev (1999)

Research and development (R&D) is one of a firm's key activities in today's knowledge economy and, to a great extent, determines the growth and uncertainty of a firm's long-term value. Since the 1970s, U.S. public firms have significantly raised their R&D investments; in fact, their R&D investments increased faster than capital expenditures (Jensen, 1993; Skinner, 2008). These heavy investments in R&D are perceived as value-relevant for stock investors as prior studies based on U.S. data have shown that R&D-intensive firms are associated with higher market value (Griliches, 1981; Hall, 1993; Sougiannis, 1994) and higher subsequent stock returns (Lev and Sougiannis, 1996; Lev, 1999; Chan, Lakonishok, and Sougiannis, 2001). Although such a positive R&D-return relation has been confirmed by subsequent studies, whether such a relation is driven by risk premium, market frictions, or behavioral biases remains an important issue under debate and calling for further analyses.

R&D spending also rose globally. Non-U.S. firms have become more aggressive in engaging in R&D activities. In fact, nine of top 20 global R&D spenders in 2014 are not based in U.S.[1] In the Worldscope database, total R&D expenditures reported by non-U.S. public firms have increased 10.45% annually from 1980 to 2008, in comparison with an annual increase rate of 7.89% from U.S. firms. All these observations suggest a global phenomenon of intensive R&D activities, which motivate us to analyze asset pricing implications of R&D from an international perspective.

[1] According to PwC's Strategy (http://www.strategyand.pwc.com/global/home/what-we-think/innovation1000/top-innovators-spenders), these nine non-U.S. companies include (ranks in parentheses): Volkswagen (1), Samsung (2), Roche (5), Novartis (6), Toyota (7), Daimler (12), Sanofi-Aventis (16), Honda (17), and GlaxoSmithKline (19).

In this paper, we examine the cross-sectional return predictive ability of R&D in international equity markets.[2] Our investigation may contribute to the understandings of the role of intangible assets in asset pricing, especially from the perspective of technological innovation, from three angles: first, the heterogeneity in institutional environments across countries enables us to analyze whether the R&D effect can be explained by some country-specific factors. Second, the cross-section of stock returns spanned by all countries in the Datastream database not only allows us to conduct an out-of-sample test for the R&D-return relation reported in U.S. stock markets, but also enables us to better understand the causes of the R&D effect. Third, there are only few studies of the R&D effect in non-U.S. countries (Canada, France, and U.K. for example),[3] and there is a lack of asset pricing tests in a cross-country setting. Our investigation thus fills in this gap in the finance literature.

Lev and Sougiannis (1996) could be among the first in reporting that U.S. public firms' R&D intensity predicts these firms' subsequent stock returns and profitability with controlling for size, book-to-market ratio, and survivorship bias. They conclude that R&D investments are value-relevant and suggest future studies to examine whether such an R&D effect results from investors' under-reaction to R&D information or extra systematic risk related to R&D investments. Subsequent studies on the R&D effect, mostly based on U.S. data, collectively suggest three possible explanations: risk premium, behavioral biases, or market frictions.[4] R&D investments can be regarded as creating growth options and may increase firms' exposure to unspecified systematic risk. On the other hand, investors may be pessimistic in assessing the value of R&D activities and thus tend to over-discount

[2] Using international data to reexamine specific patterns found in U.S. markets helps us guard data mining bias and provides new insights on the causes and consequences of these patterns. For example, Fama and French (1998) present international evidence for the value premium based on 13 countries. Rouwenhorst (1998) shows that the momentum effect exists in 12 European markets. McLean, Pontiff, and Watanabe (2009) report negative subsequent stock returns associated with share-issuance in 41 non-U.S. markets. Watanabe et al. (2013) show that firms with higher asset growth subsequently experiences lower stock returns in 51 stock markets. In addition, Eisdorfer, Goyal, and Zhdanov (2014) explore the distress anomaly using 34 countries.

[3] For example, the relation between R&D intensity and subsequent stock returns has been studied using Canadian data by Callimaci and Landry (2004), using French data by Cazavan-Jeny and Jeanjean (2006), and using U.K. data by Oswald and Zarowin (2007).

[4] Chan, Lakonishok, and Sougiannis (2001) confirm the finding of Lev and Sougiannis (1996) after taking more systematic risk factors and prior stock performance into account, and advocate the behavioral biases explanation by arguing that investors tend to be over-pessimistic about R&D activities. This viewpoint is further supported by Eberhart, Maxwell, and Siddique (2004, 2008), which report higher abnormal stock returns and higher abnormal operating performance after substantial R&D increases. Market frictions explanation suggests that investors under-react to R&D news because of information lags or limited risk-bearing due to financial constraints (see Penman and Zhang, 2002; Lev, Sarath, and Sougiannis, 2005; Ciftci, Lev, and Radhakrishnan, 2011). Lastly, some studies support the risk premium explanation as R&D activities may create growth options or may increase systematic risk exposure (e.g., Kothari, Laguerre, and Leone, 2002; Chambers, Jennings, and Thompson, 2002; Berk, Green, and Naik, 2004; Li, 2011; Lin, 2012).

future cash flows associated with innovations. Moreover, given the existence of market frictions in information and financial constraints, some investors may have information advantages or have the capacity to bear higher risk and thus can exploit R&D information.

This paper proceeds in three stages. In the first stage, we test whether R&D-intensive firms also provide higher subsequent stock returns using both sorted portfolios and Fama-MacBeth regressions. In the second stage, we study if the R&D effect can be explained by country-specific institutional factors related to risk premiums, market frictions, or behavioral biases by examining which factors explain the high-minus-low return spreads and Fama-MacBeth regression slopes. In the third stage, we use firm-level data to further justify the explanation supported in the second stage.

Using an unbalanced panel of public firms listed in 20 countries with stock returns from 1981 July to 2012 June in the Datastream and Worldscope databases, we find that R&D-intensive firms are associated with higher subsequent stock returns. Our primary proxy for R&D intensity is defined as a firm's annual R&D expenditures divided by its book equity. We do not use market equity to scale R&D expenditures because it may bias the explanatory power of R&D for two reasons: first, market equity may have changed immediately following the announcements of R&D increases; and second, market equity is known to predict stock returns as the size effect. Nevertheless, in robustness checks, we also consider alternative proxies by using R&D capital defined as Chan, Lakonishok, and Sougiannis (2001) as numerator and using market equity or change in book equity as denominator.

In one-way portfolio analyses, we sort all stocks reporting R&D expenditures into quintile portfolios by their R&D intensity, and then track the equal- and value-weighted portfolio returns for the 12 months starting from July in the next year. We consider both global sorting and country-neutral sorting. In the global sorting, the top quintile portfolio outperforms the bottom one by a significant 0.75% (0.25%) per month in equal-weighted (value-weighted) returns. When we conduct country-neutral sorting by sorting all stocks reporting R&D expenditures within each country into quintile portfolios,[5] we find that the top quintile portfolio outperforms the bottom one by a significant 0.58% (0.24%) per month in equal-weighted (value-weighted) returns. Similar results are found when we exclude U.S. firms from the sample. Furthermore, we find that these top-minus-bottom return

[5]The country-neutral sorting approach mitigates the influence of large firms from developed countries and also appropriately controls for different accounting standards and tax credits for R&D.

spreads cannot be explained by international return factors of Hou, Karolyi, and Kho (2011).

We are concerned that the positive return spreads associated with R&D intensity may be driven by large firms because they have higher incentive to invest in R&D due to economies of scale in learning, financial stability, and diversified product lines (e.g., Cohen, Levin, and Mowery, 1987; Acs and Audretsch, 1987), or by small firms that are riskier in spending on big projects (Li, 2011). Thus, we conduct two-way sorted portfolios by sorting all stocks independently into R&D intensity quintiles and market equity quintiles. We find that the R&D effect does not concentrate in the smallest or largest quintile. Instead, it is strongest in three mid-sized quintiles. In addition, the average returns of all five portfolios in the high R&D intensity quintile significantly outperform the average returns of all five portfolios in the low R&D intensity quintile by 0.77% per month.

Fama-MacBeth regression results including country and industry fixed effects suggest that the return-predictive power of R&D intensity remains significant after controlling for size, book-to-market, momentum, profitability, and asset growth. When U.S. firms are included (excluded), the slopes on R&D intensity range from 0.014 to 0.018 (0.007 to 0.015) per month. We obtain similar results when we use market equity to weigh the Fama-MacBeth regressions. Our analyses suggest that the R&D effect exists in international equity market and cannot be attributed to exposure to common risk factors and firm characteristics. It is noteworthy that our results based on country-neutral sorting and Fama-MacBeth regressions including country fixed effects eliminate the influence of country-specific factors, such as currency risk and political and economic uncertainty, on the level of stock returns.

We then focus on the role of country-specific factors in the R&D effect (i.e., the sensitivity of stock returns to R&D intensity). The idea is to quantify the magnitude of R&D effect in each country in a month, and then to examine if the effect can be explained by country-level proxies that reflect various possible reasons for the return predictability. Corresponding to the three explanations based on risk premium, market frictions, and behavioral biases, we construct three sets of country-level proxies for growth option risk, limits-to-arbitrage, and sentiments, respectively.

Four measures to quantify the R&D effect are constructed for each country in a month: top-minus-bottom R&D spreads (both equal- and value-weighted) and the slopes on R&D intensity from cross-sectional regressions (both equal- and value-weighted). For each country in every month, we sort all stocks reporting R&D expenditures into quintile portfolios and then track the equal- and value-weighted returns of the top-minus-bottom portfolio to form country-specific R&D spreads. To form country-specific R&D slopes, we conduct cross-sectional regressions to calculate the slope on R&D intensity across all firms in one country in one month using equal- and value-weighted least squares. These four measures present substantial variation of R&D effects across countries to be explained.

The first set of country-level proxies for growth option risk consists of dispersions in price dividend ratios, and dispersion in the present value of growth options (Long, Wald, and Zhang, 2005; Cao, Simin, and Zhao, 2008). We argue that large spread in the market valuation ratios indicates that the risk premium of growth options are more likely to be priced. If the R&D effect is driven by risk, we expect it to be more pronounced in countries with larger dispersion in growth option value because R&D investments create growth options.[6]

The second set of proxies for limits-to-arbitrage, we consider short-sale permission (Bris, Goetzmann, and Zhu, 2007; McLean, Pontiff, and Watanabe, 2009), idiosyncratic volatility (Li and Zhang, 2010), and dollar trading volume (Watanabe et al., 2013). Limits-to-arbitrage impose higher costs and risks on investors with information advantages and thus weaken the R&D effect that is driven by market frictions. The third set of proxies for sentiments, we consider the number of IPO and volatility premium, both proposed by Baker, Wurgler, and Yuan (2012). If the R&D effect is driven by investors' behavioral biases (mainly "high-tech fad"), it is expected to be correlated with these sentiment proxies.

After constructing country-month panels of R&D spreads and slopes, we regress these R&D effect measures on country-specific variables for growth option value, limits-to-arbitrage, or sentiments. We find that R&D spreads and slopes can be significantly explained by growth option proxies but not by the proxies for limits-to-arbitrage or sentiments. These results indicate that, in markets with higher value to growth options, stock returns are more sensitive to R&D activities as these markets recognize the value of growth options driven by R&D investments. Our country-level analyses suggest that the R&D effect could be attributed to risk premiums rather than market frictions or behavioral bias.

[6] The literature has suggested that R&D investments increase growth options and thus lead to higher risk premium (e.g., Berk, Green, and Naik, 1999; Carlson, Fisher, and Giammarino, 2004; Zhang, 2005; Garleanu, Panageas, and Yu, 2012; Ai and Kiku, 2013; Kogan and Papanikolaou, 2014).

Lastly, we conduct firm-level analyses to further justify the risk channel through which R&D investments lead to higher expected returns. Specifically, we examine if R&D investments are associated with higher market-to-book ratio, higher future profitability, and higher future return volatility. Empirical results based on Fama-MacBeth regressions indicate that R&D investments not only increase firms' growth option value and operating performance but also increase volatility in stock returns, consistent with more R&D-induced growth options. As a result, we provide empirical evidence at both country- and firm-levels for a risk-based explanation for the R&D-return relation.

This paper contributes to the finance literature as follows. First, we find a cross-country pattern that R&D-intensive firms are associated with higher subsequent stock returns, which serves as out-of-sample evidence for prior findings in the U.S. We then present both country- and firm-level evidence supporting a risk-based explanation for our findings: R&D investments increase firms' growth options and thus lead to higher expected stock returns as growth options are risky. Our test results from specifying the risk channel corroborate the implications of previous theoretical models of Berk, Green, and Naik (1999), Carlson, Fisher, and Giammarino (2004), Zhang (2005), Garleanu, Panageas, and Yu (2012), Ai and Kiku (2013), and Kogan and Papanikolaou (2014).

The rest of the paper is organized as follows. Section 2 describes the data sources and variable construction. Section 3 presents our portfolio and regression analyses for the R&D-return relation. Section 4 examines if country-specific variables explain the R&D effect, and Section 5 further analyzes the channel through which R&D intensity affects subsequent stock returns at the firm level. Section 6 concludes.

2 Data

We obtain the data on stock market variables and company accounting items for all international firms from Thomson-Reuters Datastream and Worldscope databases. Our data are the same as those used in Watanabe et al. (2013) and we end up with 20 countries for which stock returns and non-missing R&D data are available. We consider only firms listed in the largest stock exchange in most countries except Japan (Tokyo and Osaka), and the U.S. (NYSE, Amex, and Nasdaq). Since data errors are common in international data, we impose the standard filters suggested by Ince and Porter (2006) to ensure the quality of the data from the Datastream database. We also follow McLean, Pontiff, and Watanabe (2009) to winsorize all variables from the Worldscope database at the top and bottom one percentiles of their distributions within each country. We take a U.S. investor's perspective and report all results on returns denominated in U.S. dollars. Firms in financial industries with Datastream industry codes (INDM) corresponding to the four-digit SIC (Standard Industrial Classification) codes between 6000 and 6999 are removed from our sample.

Our primary measure for R&D intensity for firm i in year t is defined as firm i's annual R&D expenditure (Worldscope item 01201) reported in fiscal year t divided by the firm's book equity (BE) at the end of fiscal year t. BE is defined as stockholders' equity minus value of preferred stock (item 03451) plus deferred taxes and investment tax credit (item 04101), following Davis, Fama, and French (2000) and Hou, Xue, and Zhang (2014). It is worth noting that on average 69.95% of our whole sample report either missing or zero R&D expense, although this portion varies by country over time. Following the literature, we only include firm-year observations with positive R&D expenditures in the sample.

Several issues regarding our definition of R&D intensity are worth discussions. Unlike prior studies using market equity (e.g., Chan, Lakonishok, and Sougiannis, 2001), we use book equity as the deflating factor for R&D investments following Sougiannis (1994), Lev and Sougiannis (1996), and Kothari, Laguerre, and Leone (2002). Market equity itself is found to predict stock returns (i.e., the size effect), and increases with reported R&D expenditures (Griliches, 1981; Hall, 1993; Sougiannis, 1994). Another possible deflator for R&D expenditure is sales (e.g., Lev and Sougiannis, 1996; Chan, Lakonishok, and Sougiannis), which is not used in this study because sales data is volatile in international data. Nevertheless, we obtain consistent results using alternative proxies by using R&D capital (i.e., accumulated five-year R&D expenditures with a 20% obsolescence rate) defined as Chan, Lakonishok, and Sougiannis (2001) as the numerator and using market capitalization or change in book equity as the denominator.

All these procedures lead to a sample consisting of 302,595 firm-year observations when the U.S. is included and 217,109 observations when the U.S. is excluded. The country-level summary statistics for the sample including the U.S. is reported in Table 1. It is noted that the data for most developed countries are available in the early 1980s, while the data coverage for emerging countries is more limited. Most developed countries enter into our sample in July 1981, while Greece and Turkey are the latest entrant (Dec 1987). U.S. firms account for 28.25% of the total firm-year observations and 47.58% of the total market capitalization. In Table 1, we list the median and standard deviation of R&D intensity. We find that firms in Canada leads the world in terms of R&D intensity. In addition, there is noticeable cross-country variation in these statistics, with the median R&D intensity ranging between 0.79% (Malaysia) and 21.57% (Canada) and the standard deviation ranging between 1.41% (Malaysia) and 40.79% (Canada).

Table 1 about here.

3 Empirical Analysis

3.1 Portfolios analysis

We consider three different one-way sorted portfolios to examine the R&D effect. To ensure our portfolios do not include micro-caps that are hard to trade, we exclude the bottom 10% market value firms for each country. In addition, we require each country-month cross-section to have at least 50 firms to be sorted. Our first approach is global sorting, in which we rank all sample firms by their R&D intensity measures in year t-1 and then sort them into five equal-sized quintile portfolios in the beginning of July in year t. The low quintile contains the 20% of firms with the lowest R&D intensity, while the high quintile consists of the 20% with the highest R&D intensity. For each month from July in year t to June in year t+1, we calculate the equal-weighted returns of each portfolio using the simple average of the monthly returns of all stocks in each quintile, and the value-weighted returns of each portfolio using the weighted average of the monthly returns of all stocks weighted by lagged market capitalization in each quintile. As reported in Table 2, the five quintile portfolios (from low to high) provide equal-weighted returns of 1.26%, 1.19%, 1.29%, 1.44%, and 2.02% per month. The return spread between the high and low quintiles is 0.75% per month with a t-statistic of 2.91. The value-weighed returns of the five quintile portfolios (from low to high) are 0.88%, 0.92%, 0.87%, 1.00%, and 1.12% per month. The return spread between the high and low quintiles is 0.25% per month with a t-statistic of 1.37.[7] Our finding that the equal-weighted spread is more significant than the value-weighted one is consistent with Chan, Lakonishok, and Sougiannis (2001) and Eberhart, Maxwell, and Siddique (2004 and 2007), and suggests that substantially higher subsequent returns for more intensive R&D investments are more pronounced among firms that are not giants. Given that insignificant results in the value-weighted spread due to the dominating role of large firms, we resort to two-way sorted portfolios to further control for the size effect in the next subsection.

Our second approach is country-neutral sorting, in which we rank all sample firms in one country by their R&D intensity measures in year t-1 and then sort them into five equal-sized quintile portfolios in the beginning of July in year t. We then pool all firms ranked in the same quintile across all countries to form country-neutral portfolios. In comparison with the first approach, such a sorting not only prevents the situation that some quintiles are loaded with firms from specific countries but also appropriately control for different accounting standards and tax credits for R&D. The averages of the equal-weighted returns of the high and low portfolio are 1.89% and 1.31%, respectively; in addition, the averages of the value-weighted returns of the high and low portfolio are 1.37% and 1.13%, respectively. The return spread based on equal-weighted returns is a statistically significant 0.58% (t=3.34), while return spread based on value-weighted returns is again a statistically insignificant 0.24% (t=1.20).

Our third approach is country-neutral sorting without U.S. firms. The same procedure as the second approach is implemented except that we do not include U.S. firms in each quintile so that we are able to examine if the R&D effect still holds out of U.S. markets. The return spread based on equal-weighted returns is a statistically significant 0.49% (t=2.58), while the return spread based on value-weighted returns is again a statistically insignificant 0.14% (t=0.56) We find a similar pattern in all three sorting approaches, suggesting that the R&D-return relation is a global phenomenon and serving as out-of-sample evidence for the R&D effect reported in U.S.-based analyses.

Table 2 about here.

The results presented in Table 2 suggest that the R&D effect is more pronounced in equal-weighted

[7] Nevertheless, as we will show later, the value-weighted spread becomes significant after we control for global factors of Hou, Karolyi, and Kho (2011).

portfolios than in value-weighted portfolios around the world, which is similar to prior studies using U.S. data (Chan, Lakonishok, and Sougiannis, 2001; Eberhart, Maxwell, and Siddique, 2004 and 2007). To further understand such a phenomenon and to separate the R&D effect from the size effect, we conduct two-way portfolio sorting based on market capitalization and R&D intensity. Based on the global sorting approach, all sample firms are ranked by market capitalization at the end of year *t*-1 and then sorted into five quintile portfolios in the beginning of July in year *t*. In addition, all sample firms are ranked by their R&D intensity in year *t*-1 and then sorted into five quintile portfolios in the beginning of July in year *t*. The intersection of these two sorting leads to 25 portfolios, and the equal- and value-weighted returns of these portfolios are tracked from July in year *t* to June in year *t*+1. Table 3 shows that the R&D effects exist within all the size groups for both equal- and value-weighted portfolios. Such a pattern exists in both equal- and value-weighted portfolios (Panels A and B, respectively).

We also calculate the high-minus-low spread for the high and low R&D intensity portfolios within each size quintile. The spread and t-statistics are presented in the bottom two rows of two panels. In Panel A, the high-minus-low spreads of the five size quintile portfolios (from small to big) are 0.55%, 0.81%, 1.11%, 0.99%, and 0.41% per month with t-statistics of 1.78, 2.56, 3.43, 3.25, and 1.92, respectively. In addition, a size-neutral high-minus-low spread is calculated by averaging the high-minus-low spreads across size quintiles following Fama and French (1993), and appears to be substantial (the average is 0.77% with a t-statistic of 2.61), which is close to the counterpart in Table 2 (0.75%). Similar results are reported in Panel B based on value-weighted portfolios. In comparison with Table 2, we find a sharper contrast in the returns between high and low R&D-intensity portfolios in mid-sized portfolios. These results not only confirm the R&D effect but also suggest that the R&D effect is driven by neither gigantic firms nor micro-cap firms.

Table 3 about here.

The return patterns presented in Table 2 may be attributed to higher risk exposure to international risk factors related to R&D investments. Thus, we regress all high-minus-low spreads on the three factors proposed by Hou, Karolyi, and Kho (2011) that include a global market factor (Rm_rf), a global cash-to-price factor ($F_{C/P}$), and a global momentum factor (F_{MOM}). In Table 4, we find that the alphas from the three-factor model in fact are in fact higher than return spreads. For example, the equal-weighted alpha from are global sorting is 0.73% (t=2.30), which is close to the equal-weighted high-minus-low spread of 0.75%. More importantly, we find that the value-weighted alpha is a positive 0.37% with a t-statistic of 1.94. These results suggest that the R&D effect cannot be explained by common factors that explain common variation in global stock returns. In addition, we also find that the R&D spreads are positively loaded on the global market factor and negatively loaded on the global cash-to-price factor. Such a pattern is reasonable as R&D investments naturally increase a firm's market risk while lower a firm's cash positions.

Table 4 about here.

Overall, all results reported in Tables 2 to 4 based on various sorted portfolios and different linear risk factor models provide strong support to an R&D effect on subsequent stock returns in international stock markets.

3.2 Fama-MacBeth regressions

Lev and Sougiannis (2008) and subsequent studies employ Fama-MacBeth regressions to examine whether the U.S. R&D effect is robust to the control of return-predictive power of many firm characteristic variables including size, book-to-market ratio, and earnings. In this section, we employ the same approach to examine an international R&D effect and include more factors including momentum, return on equity (ROE), asset growth, industry dummies, and country dummies.

In each month from July of year t to June of year t+1, we conduct a cross-sectional regression in which we regress the stock returns of all sample stocks from all countries on corresponding R&D intensity, size (ME), book-to-market ratio (BM), momentum (MOM), return on equity (ROE), asset growth (AG), industry dummies, and country dummies. R&D intensity has been defined in earlier context. ME is defined as the natural logarithm of market capitalization (Datastream variable MV) at the end of year t-1. BM is defined as the natural logarithm of the book value in fiscal year t-1 scaled by market capitalization at the end of year t-1. MOM is defined as the five-month cumulative return from January to May in year t (computed using the monthly percentage change in Datastream return index RI), which leaves one-month gap for short-term reversal following the literature. ROE is defined as net income minus preferred dividends over common equity in fiscal year t-1, and asset growth is defined as the change of total assets over lagged total assets in fiscal year t-1. It is necessary for us to control for industry dummies because there is substantial cross-industry variation in R&D expenditures and intensity due to different natures of industries (e.g., Chan, Lakonishok, and Sougiannis, 2001) and the expected costs of capital also vary across countries (Fama and French, 1997). More importantly, we also include country dummies because there may exist country-level attributes such as currency risk and political instability that may affect the level of stock returns in a particular period.

Table 5 reports the time-series averages and associated t-statistics of the estimated coefficients from the cross-sectional regressions, which again support an international R&D effect. We do not report the average coefficients on industry and country fixed effects for the sake of brevity. Panel A presents the results using all 20 countries and Panel B presents the results excluding U.S. firms. In Panel A, we find that the average coefficients of R&D intensity range from 0.014 to 0.018 per month with t-statistics above 2.0. When we only control for industry and country fixed effects, the average coefficient of R&D intensity is 0.014 per month. This value increases to 0.018 per month when three commonly used firm characteristics (ME, BM, and MOM) are added to the regression. When we further include ROE and AG, the average coefficient of R&D intensity becomes 0.016. We find similar yet weaker results in Panel B, in which the average coefficient of R&D intensity is 0.013 per month after controlling for all characteristics. These findings suggest that the R&D effect is not associated with common firm characteristics.

Table 5 about here.

We report in Panel C the results of value-weighted Fama-MacBeth regressions in which the weight is firms' market value denominated in U.S. dollars. We find that the average coefficients of R&D intensity range from 0.011 to 0.028 per month with t-statistics ranging from 1.84 to 2.42. When we only control for industry and country fixed effects, the average coefficient of R&D intensity is 0.028 per month. This value changes to 0.015 per month when three commonly used firm characteristics

(ME, BM, and MOM) are added to the regression. When we further include ROE and AG, the average coefficient of R&D intensity becomes 0.011. We find similar yet weaker results in Panel D where we exclude U.S. stocks, in which the average coefficient of R&D intensity is 0.013 (t=1.78) per month after controlling for all characteristics.

4 Cross-country Analysis

To further investigate the differences in stock returns as well as to better understand the source of return predictability, we turn to country-level analysis. By treating each country as a sample point, we examine which country characteristics explain the magnitude of the R&D effect cross countries, following Watanabe et al. (2013) and Eisdorfer, Goyal, and Zhdanov (2014). Our strategy is to quantify the magnitude of the R&D effect (i.e., the sensitivity of stock returns to R&D intensity) in each country in a year, and then to examine if this effect can be explained by country-specific variables that reflect various possible reasons for the return predictability. We quantify the R&D effect for each country in a month using four measures: top-minus-bottom R&D spreads (both equal- and value-weighted) and R&D slopes from the cross-sectional regressions (both equal- and value-weighted). We again require all the investment strategy to have the limitation of 50 firms within each cross section to sort with in each country every year, and then track the equal- and value-weighted returns of the top-minus-bottom portfolio to calculate the monthly R&D spread from July of year t to June of year t+1. We calculate R&D slopes as follows. For each month from July of year t to June of year t+1, we conduct cross-sectional regressions by regressing monthly stock returns on R&D intensity in year t-1 to calculate the monthly R&D slope using equal- and value-weighted least squares.

We construct three sets of country-specific variables for growth option dispersion, limits-to-arbitrage, and sentiments that correspond to the explanations based on risk premium, market frictions, and behavioral biases, respectively. The first set consists of dispersion in price-dividend ratios, the value of which is shown to predict future economic growth (Bekaert, Harvey, Lundblad, and Siegel, 2007), and the dispersion in the present value of growth options (Long, Wald, and Zhang, 2005; Cao, Simin, and Zhao, 2008). The present value of growth options is calculated as follows: First, for each firm, we use previous four years' ROE to compute a weighted average ROE for year t with declining weights of 0.4, 0.3, 0.2 and 0.1 for years t, t-1, t-2 and t-3. We then obtain the projected earning by multiplying this average ROE by the end-of-period book value of long-term liability not including debt. Second, we estimate the value of asset-in-place, defined as the discounted projected-cash-flows. We follow Cao, Simin, and Zhao (2008) to assume a market beta of one for all, then aggregate all firm-level returns to calculate a country-year's average market returns. Finally, we obtain the PVGO, the total market value of equity minus the value of asset-in-place divided by the total market value of equity. Higher values in these variables suggest that the risk and value growth options are more likely priced.

In the second set of proxies for limits-to-arbitrage, we consider short-sale permission, idiosyncratic risk, and dollar trading volume (Watanabe et al., 2013). Short-sale permission (SHORT) is a dummy variable equal to one if short-selling is allowed and zero otherwise. We obtain this information from Bris, Goetzmann, and Zhu (2007). In addition, if short-selling was legal prior to 1990, we assume that short-selling was allowed in each of the years before 1990 following McLean, Pontiff, and Watanabe (2009). Idiosyncratic risk (IRISK) is the annual value-weighted average of idiosyncratic volatility of all stocks in a country. For each stock, its idiosyncratic risk is the standard deviation of the residuals from regressing daily stock returns on the value-weighted market returns from July 1st of year t-1 to June 30th of year t following Li and Zhang (2010). Dollar trading volume (DVOL) is the annual value-weighted average of dollar trading volume for all stocks in a country. Each stock's dollar trading volume is the product of share volume and daily closing price, summed from July of year t-1 to June of year t (Watanabe et al., 2013). Since limits-to-arbitrage impose higher costs and risks on investors with information advantages, it is expected to weaken the R&D effect driven by market frictions.

In the third set of proxies for sentiments, we consider the number of IPO and volatility premium (Baker, Wurgler, and Yuan, 2012). The number of IPOs (NIPO) is the number of firms that first appear in Datastream, approximating the number of IPOs within each country's capital market. We then scale it with the total number of firms in that country that year. The volatility premium (PVOL) is the log of the ratio of the value-weighted average market-to-book ratio of high volatility stocks to that of low volatility stocks at year end. High (low) volatility stocks are those in the top (bottom) three deciles of the variance of the previous year's monthly returns, where decile break points are determined in each country every year. If the R&D effect is driven by investors' behavioral biases (mainly "high-tech fad"), it is expected to be correlated with these sentiment proxies.

After constructing country-month panels of R&D spreads and slopes as well as country-specific variables, we present the time-series averages of all these variables for 20 countries in Table 6. While all the R&D effect measures (spreads and slopes) are measured monthly, the rest variables are measured annually.

Table 6 about here.

In Table 7, we report the pooling correlations among all these variables. We first find that the correlation between the equal- and value-weighted R&D spreads (EWSPRD and VWSPRD) is 0.32, and the correlation between the equal- and value-weighted R&D slopes (EWSLOPE and VWSLOPE) is 0.78 with statistical significance. Within the dispersions in growth options set, PE and PVGO are correlated at 0.164. Within in the limits-to-arbitrage set, IVOL is negatively correlated with SHORT and DVOL (-0.12 and -0.17), and SHORT and DVOL is positively correlated (0.39). These correlations are insignificant. Within the sentiment set, the correlation coefficient between NIPO and PVOL is 0.44, which is statistically significant.

Table 7 about here.

We next present cross-country regression results in Tables 8 to 11, where the dependent variables are either spreads or slopes covering July of year t to June of year t+1, while the independent variables are country-specific variables at the end of June of year t (or in the year end of year t-1). We report the pooling regression results with yearly fixed effects, and cluster the standard errors both along countries and along time. The regression analysis thus also delivers implications for investment strategies. For convenience, we express the spreads and slopes in percentage points.

Table 8 reports the estimation results from regressing the four measures for the R&D effect on country-specific variables for dispersions in growth options. We find that R&D spreads and slopes can be significantly explained by growth option dispersions. For example, in the left part of Panel

A for equally-weighted spreads, the coefficients of dispersion in PVGO and PE are 0.094 and 0.024 with t-statistics of 1.82 and 2.57, respectively, when only each of these variables exists in regressions (Models 1 to 2). In terms of economic significance, when dispersions in PVGO and PE increase by one standard deviation, the R&D spread increases by 0.11%, and 0.10% per month, respectively. When we include both variables in the same regression (Model 3), the coefficients on dispersions in PE and PVGO are similar in both economic and statistical significance. In the right part of Panel A for value-weighted spreads, the coefficients of dispersions in PVGo and PE are 0.056 and 0.022 with t-statistics of 1.72 and 2.60, respectively, in Models 1 and 2. When dispersions in PVGO and PE increase by one standard deviation, the R&D slope increases by 2.60%, and 4.14% per month, respectively. When we move to the equal- and value-weighted slopes, the results are albeit weaker but still largely consistent. These results support a risk-based explanation for the international R&D effect: if the effect is associated with growth option risk, it is expected to be more pronounced in countries with higher growth option value because R&D-induced growth options are more likely priced in these countries.

Table 8 about here.

Table 9 presents the estimation results from regressing the R&D effect measures on limits-to-arbitrage proxies and suggests that R&D spreads and slopes cannot be explained by market friction. For example, in Panel A for equal-weighted spreads, the coefficients of SHORT, IRISK, and DVOL are 0.294, 0.139, and 0.047 with t-statistics of 1.32, 0.98, and 1.13, respectively, in Models 1 to 3. For value-weighted spreads, the coefficients of SHORT, IRISK, and DVOL are -0.138, 0.234, and -0.017 with t-statistics of -1.22, 2.35, and -0.44, respectively, in Models 1 to 3. We note that the value-weighted slope is strongly positively related to the IRISK, consistent with the findings in Watanabe et al. When we include all three variables in a regression (Model 4), we find similar results that these country-specific variables for market friction generally cannot explain the international R&D effect. Particularly, for equal-weighted spreads, in the multiple regression the coefficient on the SHORT is positive, suggesting that countries allowing short sell actually have stronger RD effects. The statistical signficance of SHORT coefficient can also be detected when we use either equal- or value-weighted slopes as the dependent variable in panel B.

Table 9 about here.

Next in Table 10, we regress the R&D effect measures on two sentiment proxies and find that R&D spreads and slopes cannot be attributed to these variables as shown in Table 10. For example, in Panel A for equal-weighted spreads, the coefficients of NIPO and PVOL are -0.141 and -0.011 with t-statistics of -0.09 and -0.10, respectively, when only one variable exists in regressions. Similarly, we find insignificant coefficients in Model 3 that includes both variables for market sentiment. Moreover, we do not detect any significant results when we vary the dependent variables, indicating the lack of explanatory power of these measures.

Table 10 about here.

Given the sharpe contrast between the explanatory power of growth option dispersions and that of the limits-to-arbitrage and sentiments, we follow Watanabe et al. and conduct a joint estimation examining the role of either proxy of dispersion in growth options, after controlling the proxies of limist-to-arbitrage and sentiments.

In Table 11 we re-examine the explanatory power of dispersions in PVGO controlling for the other variables, namely, SHORT, IRISK, DVOL, NIPO and PVOL. Again, we find that the explanatory power of dispersions in PVGO is very robust, and does not weaken in any of the models. This pattern does not appear in equal-weighted slope, where dispersion in PVGO does not explain the R&D effect by itself anyway. For example, in Table 8 where the dependent variable is equally-weighted spread, the coefficient of PVGO is 0.094. Controlling for all the other explanations, we still observe the coefficient of PVGO ranging betwen 0.078 and 0.095, especially with an estimate of 0.090 controlling for all the 5 other explanations, and still with a t-value of 1.71.

Table 11 about here.

In Table 12 we similarly re-examine the explanatory power of dispersions in PE controlling for the other variables, namely, SHORT, IRISK, DVOL, NIPO and PVOL. We first add one variable at a time, then 5 variables jointly. Again, we have four dependent variables, and panels A to D report each set of result. Overall, we find that the explanatory power of dispersions in PE is very robust, and does not weaken in any of the models. This pattern again does not appear in value-weighted slope, where dispersion in PE does not explain the R&D effect by itself anyway. For example, in Table 8 where the dependent variable is equally-weighted spread, the coefficient of PE is 0.024. Controlling for all the other explanations, we still observe the coefficient of PE ranging betwen 0.020 and 0.029, especially with an estimate of 0.025 controlling for all the 5 other explanations, and still with a t-value of 2.26.

Table 12 about here.

Tables 8 to 11 collectively suggest that a stronger country-level R&D effect can be explained by diespersions in growth option measures but not by limits-to-arbitrage or sentiment measures. Our empirical evidence from cross-country analysis indicates that the international R&D-return relation is more likely driven by risk premiums associated with growth options increasing with R&D investments.

5 Firm-level Analysis

To further confirm a risk premium-based explanation for the international R&D effect, we resort to firm-level evidence. We conduct further tests to examine if more R&D-intensive firms are more profitable, present higher market-to-book ratio, and are associated with higher return volatility. These tests are motivated by the fact that more growth options lead to higher future cash flows, higher market valuation, and higher volatility in payoffs.

We use the Fama-MacBeth regression to analyze the effect of R&D intensity on future profitability. We first conduct cross-sectional regression, in which the dependent variable is operating profitability in year t+1 (pf_{t+1}) and the independent variables include R&D intensity, operating profitability (pf_{t}), ME, BM, and MOM in year t. Industry dummies and country dummies are also included. Operating performance is defined as revenue minus cost of goods sold (COGS), interest expenses, and selling, general and administrative expenses (SG&A) scaled by book equity. Then, we report the time-series averages and t-statistics in Table 11. We find that R&D intensity is associated with significantly higher operating profitability in the future. For example, in Panel A for all countries, the coefficient of R&D intensity is 0.132 with a t-statistic of 4.81 in the first column. In terms of economic magnitude, a one-standard-deviation increase in R&D intensity (20%) increases future operating profitability by 2.34%. When we only control for lagged operating profitability, industry dummies, and country dummies, the coefficient of R&D intensity is 0.121 with a t-statistic of 4.73. When we include ME, BM, and MOM in the regression, the coefficient of R&D intensity is 0.085 with a t-statistic of 2.91. Consistent albeit weaker results are presented in Panel B when U.S. firms are excluded from the sample. These results support that higher R&D intensity leads to higher future profitability as increased growth options.

Table 13 about here.

The analysis on the effect of R&D intensity on market-to-book ratios is reported in Table 12. In the cross-section of all firms in year t, we regress market-to-book ratio in year t on current R&D intensity, operating profitability (pf), stock return (ret), absolute value of operating profitability (abspf), and industry and country dummies. Table 12 presents the time-series averages and t-statistics of coefficients and shows that R&D intensity is associated with significantly higher market valuation relative to book equity. For example, in Panel A for all countries, the coefficient of R&D intensity is 1.945 with a t-statistic of 11.45. In terms of economic magnitude, a one-standard-deviation increase in R&D intensity increases market-to-book ratio by 3.9%.

Table 14 about here.

To alleviate the concern that there might be a mechanical relationship between the market-to-book ratio and current R&D intensity, which also contains book value as the scaler, we also repeat this analysis by replacing the book value with the change in the book value as the scaler in the construction of R&D intensity. The results are reported in Panel B. For all countries, the coefficient of R&D scaled by change of book value is 0.006 with a t-statistic of 3.45. In terms of economic magnitude, a one-standard-deviation increase in R&D over change of book equity (363%) increases market-to-book ratio by 2.18%. When we examine the coefficients of control variables we find they are very similar in terms of magnitude or statistical significance. Thus this additional analysis further confirms the finding that R&D intensity indeed is positively correlated with market-to-book ratio, which is consistent with an option-based explanation as the market-to-book ratio reflects the value of growth options.

We also analyze the effect of R&D intensity on future return volatility. We first conduct cross-sectional regression, in which the dependent variable is monthly return volatility between July of year t and June of year t+1 and the independent variables include R&D intensity, return volatility, ME, BM, MOM, ROE, and AG observed in June of year t. Industry dummies and country dummies are also included. The time-series averages and t-statistics of coefficients reported in Table 13 suggest that R&D intensity is associated with significantly higher return volatility in the future. For example, in Panel A for all countries, the coefficient of R&D intensity is 0.036 with a t-statistic of 8.09. A one-standard-deviation increase in R&D intensity increases future return volatility by 0.72%. Moreover, adding conventional controls does not seem to weaken the effect of R&D intensity. These results support an option-based explanation as R&D investments increase the volatility of payoffs.[8]

Table 15 about here.

Overall, Tables 11 to 13 provide firm-level evidence that R&D-intensive firms are associated with higher future profitability, higher market valuation, and higher return volatility. These results support a growth option explanation for the international R&D effect, which is consistent with country-level analyses in Section 4.

6 Conclusion

In this paper, we document that in international equity markets, firms with higher R&D intensity subsequently experience higher stock returns. This finding, combined with the U.S. evidence in the

[8]Using U.S. data, Kothari, Laguerre, and Leone (2002) have reported that R&D investments lead to more volatile profitability in the future.

literature, suggests a fundamentally important role of intangible investments in asset pricing. We find that this positive relation between R&D intensity and subsequent stock returns is stronger in countries granting higher market value to growth options, but is unrelated to country characteristics representing market sentiment and limits-of-arbitrage. Moreover, we find that R&D-intensive firms are associated with higher market-to-book ratios, higher future return volatility, and higher future profitability. The evidence suggests that the cross-sectional relation between R&D intensity and stock return is more likely attributable to risk associated with innovation than to mispricing or market friction.

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Table 1: Descriptive statistics

Country	Start date	End date	Firm-year obs	% of total obs	No. of firms per year	% of total firm	Total mkt value (USD$M)	% of total mkt value	RD median (%)	RD stdev (%)
Australia	198107	201206	15,377	5.08%	496	4.90%	240,532	1.79%	17.18%	34.33%
Canada	198107	201206	14,986	4.95%	483	4.77%	402,454	2.99%	21.57%	40.49%
Finland	198612	201206	2,304	0.76%	92	0.91%	111,775	0.83%	10.04%	12.88%
France	198107	201206	13,004	4.30%	419	4.14%	677,292	5.03%	15.70%	23.90%
Germany	198107	201206	11,175	3.69%	360	3.56%	509,062	3.78%	18.11%	23.45%
Greece	198712	201206	4,348	1.44%	181	1.79%	42,715	0.32%	2.33%	3.63%
Hong Kong	198107	201206	10,339	3.42%	334	3.29%	272,086	2.02%	4.13%	6.72%
Hungary	199101	201206	421	0.14%	22	0.22%	12,943	0.10%	6.61%	14.73%
India	198107	201206	8,236	2.72%	374	3.70%	279,052	2.07%	1.79%	3.24%
Italy	198107	201206	5,391	1.78%	174	1.72%	218,868	1.62%	9.51%	9.99%
Japan	198107	201206	49,542	16.37%	1598	15.78%	2,172,391	16.12%	5.50%	6.55%
Malaysia	198107	201206	9,782	3.23%	316	3.12%	86,996	0.65%	0.79%	1.41%
Singapore	198107	201206	5,355	1.77%	173	1.71%	123,156	0.91%	3.90%	7.86%
South Korea	198107	201206	14,271	4.72%	529	5.22%	237,252	1.76%	2.37%	3.83%
Sweden	198107	201206	5,777	1.91%	193	1.90%	153,544	1.14%	15.00%	20.10%
Switzerland	198107	201206	4,455	1.47%	144	1.42%	84,649	0.63%	15.12%	18.84%
Taiwan	198709	201206	7,900	2.61%	343	3.39%	248,441	1.84%	4.33%	4.70%
Turkey	198712	201206	2,708	0.89%	113	1.11%	38,172	0.28%	2.27%	4.56%
U.K.	198107	201206	31,738	10.49%	1024	10.11%	1,150,889	8.54%	15.21%	30.31%
U.S.	198107	201206	85,486	28.25%	2758	27.23%	6,410,444	47.58%	17.64%	28.03%
All			302,595	100.00%	10,126	100.00%	13,472,714	100.00%	11.43%	20.27%
All excluding U.S.			217,109	71.75%	7,368	72.77%	7,062,270	52.42%	8.61%	17.37%

This table provides summary statistics for the 46 markets from the Datastream-Worldscope sample. Columns 2 and 3 report the beginning and end dates during which each country is included in our sample. Each country's total number of firm-year observations, the average number of firms per year, and the average annual total market capitalization in millions of U.S. dollars are provided in columns 4, 6, and 8, respectively. The values of these statistics represented as percentages of the corresponding total across countries are given in columns 5, 7, and 9, respectively. The last two columns report the medians and standard deviations of the RD/BE for each market.

Table 2: One-way sorted portfolio returns

	Global		Country-neutral		Country-neutral (Non-U.S.)	
Weighting	Equal	Value	Equal	Value	Equal	Value
Low RD/BE	1.250	0.870	1.265	1.088	1.389	1.248
	(4.52)	(3.50)	(4.52)	(4.05)	(4.40)	(3.95)
	1.191	0.910	1.287	1.023	1.340	1.033
	(4.53)	(3.96)	(4.59)	(3.81)	(4.37)	(3.44)
	1.280	0.862	1.329	1.117	1.398	1.187
	(4.71)	(3.34)	(4.50)	(3.83)	(4.34)	(3.66)
	1.422	1.010	1.408	1.046	1.408	1.064
	(4.81)	(3.92)	(4.66)	(3.61)	(4.42)	(3.29)
High RD/BE	1.975	1.126	1.796	1.287	1.834	1.348
	(5.41)	(4.09)	(5.37)	(4.05)	(5.32)	(3.86)
High−Low	0.725***	0.256	0.531***	0.199	0.445***	0.099
t-stat	(2.97)	(1.49)	(3.23)	(1.06)	(2.46)	(0.43)

This table reports the monthly returns (in percentage) on R&D intensity (R&D/BE) sorted portfolios. At the end of June of each year, we sort stocks into five R&D intensity quintiles in three approaches: global sorting, country-neutral, and country-neutral excluding the U.S. We then compute the equal-weighted and value-weighted returns on the resulting 5 portfolios and the return spreads between the bottom and top R&D/BE quintiles (High - Low). Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2012. The rows labeled "t-Stat" show t-statistics for the High - Low return spreads. Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Table 3: Two-way sorted portfolio returns: controlling for size

Panel A: Equal-weighted portfolios						
	Small	2	3	4	Large	
Low RD/BE	0.635	1.247	1.358	1.579	1.659	
	0.541	1.168	1.306	1.532	1.560	
	0.680	1.238	1.418	1.505	1.701	
	0.563	1.327	1.662	1.847	1.737	
High RD/BE	1.126	2.043	2.460	2.582	2.113	
High−Low	0.491*	0.796***	1.102***	1.004***	0.454***	0.769***
t-stat	(1.77)	(2.80)	(3.80)	(3.70)	(2.35)	(2.89)

Panel B: Value-weighted portfolios						
	Small	2	3	4	Large	
Low RD/BE	0.932	1.273	1.351	1.571	1.502	
	0.771	1.198	1.322	1.520	1.512	
	0.916	1.252	1.472	1.546	1.596	
	0.742	1.356	1.667	1.867	1.712	
High RD/BE	1.475	2.060	2.469	2.554	1.853	
High−Low	0.544*	0.787***	1.118***	0.983***	0.351**	0.757***
t-stat	(1.88)	(2.72)	(3.89)	(3.67)	(1.98)	(2.85)

This table reports the monthly returns (in percentage) on two-way sorted portfolios, which measure the R&D effect after controlling for firm size. At the end of June of each year, we sort all stocks independently into R&D/BE quintiles and firm size quintiles. We then compute the equal-weighted (panel A) and value-weighted (panel B) returns on the resulting 25 portfolios and the return spreads between the bottom and top R&D/BE quintiles (High - Low) within each size groups. Finally, we average these return spreads and report the average and t-statistics in the last column. Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2012. The rows labeled "t-stat" show t-statistics for the High – Low return spreads. Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Table 4: Time series regression with the factors of Hou, Karolyi and Kho (2011)

	Global		Country-neutral		Country-neutral (Non-U.S.)	
Weighting	Equal	Value	Equal	Value	Equal	Value
Rm_rf	0.171***	0.029	0.100**	0.104**	0.067	0.084
	(3.073)	(0.616)	(2.513)	(2.288)	(1.490)	(1.395)
F_{MOM}	0.109	0.093	0.004	0.004	-0.024	-0.05
	(0.895)	(1.553)	(0.046)	(0.051)	(-0.305)	(-0.529)
$F_{C/P}$	-0.17	-0.284***	-0.175**	-0.143	-0.125	-0.061
	(-1.260)	(-3.929)	(-2.003)	(-1.644)	(-1.364)	(-0.597)
Intercept	0.708**	0.342*	0.611***	0.244	0.524**	0.131
	(2.286)	(1.833)	(2.950)	(1.143)	(2.423)	(0.526)
Obs	354	354	354	354	354	354

This table examines the risk-based models' explanation of portfolio returns. We conduct factor regressions of equal- and value-weighted return spreads separately, and use the Hou, Karolyi and Kho (2011) factor pricing models. These return spreads are constructed by global sorting, country-neutral sorting, and country-neutral sorting excluding U.S. firms. Returns are computed from July of year t to June of year $t+1$. The model of Hou, Karolyi and Kho (2011) includes a global market factor (Rm_rf), a global cash-to-price factor ($F_{C/P}$), and a global momentum factor (F_{MOM}). The sample period is from July of 1981 to June of 2012. The t-statistics are adjusted for time-series autocorrelation and reported in parentheses. Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Table 5: Fama-MacBeth regressions

	Panel A: Equally-weighted Fama-MacBeth regressions – All countries				
RD/BE	0.015***	0.013***	0.013***	0.018***	0.016***
	(2.834)	(2.620)	(4.152)	(5.692)	(6.973)
ME				-0.001***	-0.001***
				(-3.630)	(-3.868)
BM				0.005***	0.004***
				(7.345)	(6.829)
MOM				0.000	0.000
				(-0.381)	(-0.342)
ROE					0.001
					(0.747)
AG					-0.003***
					(-3.460)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
Obs	1321839	1321839	1304581	1268731	1180049
R^2	0.006	0.108	0.129	0.138	0.142

	Panel B: Equally-weighted Fama-MacBeth regressions – Non-U.S.				
RD/BE	0.008	0.007*	0.008**	0.015***	0.012***
	(1.419)	(1.744)	(2.249)	(4.067)	(3.756)
ME				-0.001***	-0.001***
				(-3.159)	(-3.624)
BM				0.006***	0.005***
				(7.982)	(6.965)
MOM				0.000	0.000
				(-0.158)	(-0.057)
ROE					0.002
					(1.153)
AG					-0.006***
					(-4.484)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
Obs	869199	869199	858690	834739	776764
R^2	0.006	0.165	0.195	0.205	0.204

	Panel C: Value-weighted Fama-MacBeth regressions – All countries				
RD/BE	0.027**	0.025**	0.017**	0.015**	0.010*
	(2.284)	(2.031)	(2.506)	(2.271)	(1.812)
ME				-0.005***	-0.005***
				(-6.409)	(-6.289)
BM				0.004***	0.004***

Continued on next page

				(4.243)	(3.201)
MOM				-0.002	-0.002
				(-0.893)	(-1.079)
ROE					-0.001
					(-0.642)
AG					-0.003**
					(-1.993)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
Obs	1310817	1310817	1293611	1268731	1180049
R^2	0.008	0.099	0.181	0.189	0.204
	Panel D: Value-weighted Fama-MacBeth regressions – Non-U.S.				
RD/BE	0.019*	0.013	0.01	0.015*	0.013*
	(1.870)	(1.565)	(1.376)	(1.862)	(1.816)
ME				-0.004***	-0.003***
				(-4.795)	(-4.524)
BM				0.006***	0.006***
				(4.758)	(4.227)
MOM				0.002	0.002
				(1.061)	(0.665)
ROE					0.004
					(1.350)
AG					-0.008***
					(-3.176)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
Obs	862776	862776	852305	834739	776764
R^2	0.016	0.204	0.338	0.348	0.364

This table reports the time series averages and t-statistics of the coefficients from cross sectional regressions of individual stock returns on R&D intensity, control variables, and country and industry fixed effects. Panel A reports the equal-weighted regression results for all countries, Panel B reports the equal-weighted regression results for all countries excluding the U.S., Panel C reports the value-weighted regression results for all countries, and Panel D reports the value-weighted regression results for all countries excluding the U.S. The dependent variable, stock return, is measured at the first year holding horizon after June of year t. The control variables include ME (the natural logarithm of June-end market value of year t), BM (the natural logarithm of the year $t-1$ fiscal year-end book-to-market ratio), MOM (the year t January-to-May returns), ROE (return on equity), and AG (asset growth in year t). The country/industry dummies are suppressed to save space. The t-statistics are adjusted for time-series autocorrelation and reported in the parentheses and significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 6: Country characteristics

COUNTRY	EWSPRD	VWSPRD	EWSLOPE	VWSLOPE	PE	PVGO	SHORT	IVOL	DVOL	NIPO	PVOL
Australia	0.015	0.001	0.013	-0.030	18.044	0.936	1.000	4.674	-1.147	0.153	0.452
Canada	0.021	0.004	0.019	0.028	29.306	1.255	1.000	5.134	-0.920	0.084	0.216
Finland	0.009	-0.007	0.039	0.076	15.081	0.349	1.000	1.842	-0.809	0.021	-0.348
France	0.004	0.006	-0.003	0.024	18.651	2.892	1.000	3.217	-0.527	0.077	-0.040
Germany	0.007	0.008	0.011	-0.014	19.323	2.232	1.000	3.570	-1.830	0.075	0.457
Greece	-0.012	0.000	-0.107	-0.096	21.764	2.510	0.000	2.690	1.161	0.015	-0.954
Hong Kong	0.007	0.010	0.020	0.067	13.333	1.967	1.000	3.603	-2.036	0.129	0.835
Hungary	0.005	0.003	0.005	-0.009	19.297	0.457	.	.	.	0.002	0.052
India	0.003	0.006	0.005	-0.071	19.645	1.117	0.000	4.353	-4.758	0.160	-0.433
Italy	0.002	0.004	0.010	0.014	11.744	0.985	1.000	2.069	-0.816	0.061	-0.413
Japan	0.002	0.001	0.006	0.006	28.188	1.394	1.000	2.390	-6.569	0.095	0.658
Malaysia	-0.003	-0.011	-0.116	-0.058	12.007	0.675	0.000	2.800	-4.225	0.014	-0.736
Singapore	0.004	-0.005	0.020	0.024	11.728	1.820	0.000	3.240	-2.785	0.038	-0.014
South Korea	0.006	0.010	-0.032	0.008	18.636	1.765	0.000	3.984	-6.016	0.147	0.209
Sweden	-0.003	-0.003	0.003	0.004	14.442	0.558	1.000	4.070	-2.416	0.075	0.339
Switzerland	-0.001	-0.004	-0.013	0.027	16.913	0.705	1.000	2.440	-2.194	0.029	0.062
Taiwan	0.008	0.007	0.026	-0.001	14.733	0.417	1.000	2.759	-1.237	0.138	-0.258
Turkey	0.004	0.002	-0.117	-0.138	14.159	2.240	1.000	2.474	-0.394	0.092	0.389
UK	0.002	-0.003	0.008	0.024	14.071	1.346	1.000	2.423	0.027	0.097	0.403
US	0.012	0.005	0.006	0.011	18.652	1.437	1.000	3.676	-1.291	0.088	0.229
Mean	0.005	0.002	-0.010	-0.005	17.486	1.353	0.737	3.232	-2.041	0.080	0.055
std dev	0.007	0.006	0.047	0.052	4.852	0.747	0.452	0.920	2.042	0.049	0.462

This table reports the four measures of the R&D effect and country-specific variables used in the cross-country analysis. The four measures of the R&D effect include equal-weighted spreads (EWSPRD), value-weighted spreads (VWSPRD), equal-weighted slopes (EWSLOPE), and value-weighted slopes (VWSLOPE). The country-specific variables include proxies for growth options, limits-to-arbitrage, and investor sentiment. The growth option proxies include Q (average market-to-book ratio), GGO (global growth opportunities), and PVGO (present value of growth options). The limits-to-arbitrage proxies include the average idiosyncratic stock return volatility IRISK (in percentage points), the average annual dollar trading volume DVOL (in millions), and the indicator for equity short-sale permission SHORT. The proxies for investor sentiment include the number of newly listed equities (NIPO) and volatility premium (PVOL). We report the values of these variables for each country. The last two rows report the means and standard deviations of these characteristics across all countries. The sample period is from July of 1981 to June of 2012.

Table 7: Correlations of country-specific variables

	EWSPRD	VWSPRD	EWSLOPE	VWSLOPE	PE	PVGO	SHORT	IVOL	DVOL	NIPO	PVOL
EWSPRD	1.000										
VWSPRD	0.324	1.000									
	(0.16)										
EWSLOPE	0.559	0.266	1.000								
	(0.01)	(0.26)									
VWSLOPE	0.385	0.037	0.784	1.000							
	(0.09)	(0.88)	(0.00)								
PE	0.270	0.284	0.097	-0.039	1.000						
	(0.25)	(0.22)	(0.68)	(0.87)							
PVGO	-0.155	0.418	-0.314	-0.243	0.164	1.000					
	(0.51)	(0.07)	(0.18)	(0.30)	(0.49)						
SHORT	0.426	0.156	0.453	0.387	0.078	-0.148	1.000				
	(0.07)	(0.52)	(0.05)	(0.10)	(0.75)	(0.55)					
IVOL	0.490	0.380	0.214	-0.024	0.385	0.072	-0.121	1.000			
	(0.03)	(0.11)	(0.38)	(0.92)	(0.10)	(0.77)	(0.62)				
DVOL	0.034	-0.044	-0.045	-0.047	-0.196	0.191	0.386	-0.173	1.000		
	(0.89)	(0.86)	(0.86)	(0.85)	(0.42)	(0.43)	(0.10)	(0.48)			
NIPO	0.411	0.617	0.274	-0.032	0.113	0.115	0.114	0.535	-0.289	1.000	
	(0.07)	(0.00)	(0.24)	(0.89)	(0.64)	(0.63)	(0.64)	(0.02)	(0.23)		
PVOL	0.458	0.335	0.391	0.321	0.166	0.152	0.570	0.290	-0.173	0.444	1.000
	(0.04)	(0.15)	(0.09)	(0.17)	(0.49)	(0.52)	(0.01)	(0.23)	(0.48)	(0.05)	

This table reports the correlations among the measures of the R&D effect and country-specific variables used in the cross-country analysis. The four measures of the R&D effect include equal-weighted spreads (EWSPRD), value-weighted spreads (VWSPRD), equal-weighted slopes (EWSLOPE), and value-weighted slopes (VWSLOPE). The country-specific variables include proxies for growth options, limits-to-arbitrage, and investor sentiment. The growth option proxies include Q (average market-to-book ratio), GGO (global growth opportunities), and PVGO (present value of growth options). The limits-to-arbitrage proxies include the average idiosyncratic stock return volatility IRISK (in percentage points), the average annual dollar trading volume DVOL (in millions), and the indicator for equity short-sale permission SHORT. The proxies for investor sentiment include the number of newly listed equities (NIPO) and volatility premium (PVOL). We report the values of these variables for each country. The last two rows report the means and standard deviations of these characteristics across all countries. The sample period is from July of 1981 to June of 2012.

Table 8: R&D effect and growth options

Panel A: SPREAD as dependent variable						
	Equal-weighted SPREAD			Value-weighted SPREAD		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
PVGO	0.094*		0.099**	0.056*		0.060*
	(1.819)		(2.019)	(1.724)		(1.904)
PE		0.024**	0.025***		0.022***	0.023***
		(2.572)	(2.823)		(2.597)	(2.705)
Intercept	-0.936***	-1.333***	-1.418***	-0.656	-0.674	-0.726
	(-3.966)	(-4.989)	(-5.475)	(.)	(.)	(.)
Obs	3282	3271	3271	3282	3271	3271
R^2	0.055	0.055	0.056	0.050	0.050	0.051

Panel B: SLOPE as dependent variable						
	Equal-weighted SLOPE			Value-weighted SLOPE		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
PVGO	0.162		0.178	0.442**		0.439**
	(1.149)		(1.274)	(2.077)		(2.083)
PE		0.062*	0.064*		-0.024	-0.019
		(1.740)	(1.814)		(-0.366)	(-0.285)
Intercept	-0.847	-3.808***	-3.952***	-1.049	5.254*	4.884*
	(-1.491)	(-2.695)	(-2.825)	(-0.774)	(1.804)	(1.703)
Obs	3218	3207	3207	3218	3208	3208
R^2	0.028	0.028	0.029	0.006	0.005	0.006

This table reports the results of panel regressions which examine the relation between growth options and the R&D effect on stock returns. The dependent variables are the monthly equal- and value-weighted spread (SPREAD) and slope (SLOPE). SPREAD is the equal-weighted or value-weighted average of the monthly return difference between the bottom and top R&D/BE quintile or tercile portfolios (High – Low), where their returns are cumulated from July of year t to June of year $t+1$. The value-weighting of SPREAD is based on firms' market capitalizations in June of year t. SLOPE is given by regressing buy-and-hold stock returns from July of year t to June of year $t+1$ on the R&D/BE measured over year $t-1$. The regressions are either equal-weighted or value-weighted. The value-weighted version of SLOPE is based on weighted-least-squares regressions, where the weights are proportional to market capitalizations in June of year t. Panel A reports the regression results where the equal- or value-weighted SPREAD is used as the dependent variable. Panel B presents the regression results where the equal- or value-weighted SLOPE is used as the dependent variable. The explanatory variables are the growth options proxies, including Q (average market to book ratio), GGO (global growth opportunities) and PVGO (present value of growth options). The t-statistics reported in parentheses are computed using two-way clustered standard errors by country and year (except GGO, for which clustered standard errors by country and month). Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Table 9: R&D effect and limits-to-arbitrage

Panel A: SPREAD as dependent variable								
	Equal-weighted SPREAD				Value-weighted SPREAD			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
SHORT	0.294			0.447*	-0.138			0.081
	(1.322)			(1.727)	(-1.217)			(0.455)
IVOL		0.139		0.169		0.234**		0.226**
		(0.975)		(1.294)		(2.345)		(2.172)
DVOL			0.047	0.020			-0.017	-0.017
			(1.134)	(0.574)			(-0.443)	(-0.388)
Intercept	-0.850	-1.754	3.339	-0.884	0.207	-1.094***	0.303***	-1.214**
	(-1.156)	(.)	(.)	(-1.363)	(0.223)	(-3.955)	(4.085)	(-2.208)
Obs	2872	2478	2369	2299	2872	2480	2367	2300
R^2	0.056	0.059	0.061	0.061	0.052	0.060	0.059	0.060
Panel B: SLOPE as dependent variable								
	Equal-weighted SLOPE				Value-weighted SLOPE			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
SHORT	2.562*			3.778**	3.299*			3.888***
	(1.923)			(2.443)	(1.872)			(3.156)
IVOL		0.258		0.507**		-0.647		-0.395
		(0.803)		(1.985)		(-0.702)		(-0.574)
DVOL			0.139	-0.105			0.439	0.175
			(0.706)	(-0.597)			(1.327)	(0.761)
Intercept	-3.020**	-6.023	3.039***	-4.534**	-3.283	-1.358	7.200***	6.119
	(-2.011)	(.)	(12.080)	(-2.240)	(-1.049)	(-0.608)	(22.795)	(1.295)
Obs	2813	2427	2323	2253	2813	2427	2321	2250
R^2	0.031	0.029	0.032	0.036	0.007	0.006	0.007	0.009

This table reports the results of panel regressions which examine the relation between limits-to-arbitrage and the R&D effect on stock returns. The dependent variables are the monthly equal- and value-weighted spread (SPREAD) and slope (SLOPE). SPREAD is the equal-weighted or value-weighted average of the monthly return difference between the bottom and top R&D/BE quintile or tercile portfolios (High – Low), where their returns are cumulated from July of year t to June of year $t+1$. The value-weighting of SPREAD is based on firms' market capitalizations in June of year t. SLOPE is given by regressing buy-and-hold stock returns from July of year t to June of year $t+1$ on the R&D/BE measured over year $t-1$. The regressions are either equal-weighted or value-weighted. The value-weighted version of SLOPE is based on weighted-least-squares regressions, where the weights are proportional to market capitalizations in June of year t. Panel A reports the regression results where the equal- or value-weighted SPREAD is used as the dependent variable. Panel B presents the regression results where the equal- or value-weighted SLOPE is used as the dependent variable. The explanatory variables are the limits-to-arbitrage proxies, including idiosyncratic stock return volatility (IRISK), dollar trading volume (DVOL), and permission for equity short-sale (SHORT). The t-statistics reported in parentheses are computed using two-way clustered standard errors by country and year. Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Table 10: R&D effect and sentiments

Panel A: SPREAD as dependent variable						
	Equal-weighted SPREAD			Value-weighted SPREAD		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
NIPO	-0.141		-0.007	0.320		0.535
	(-0.087)		(-0.004)	(0.304)		(0.495)
PVOL		-0.011	-0.138		0.069	0.000
		(-0.099)	(-1.067)		(0.393)	(0.002)
Intercept	0.890	-0.528***	0.799	-0.707	-0.524***	-0.529***
	(0.670)	(-10.060)	(0.586)	(-0.865)	(-6.920)	(-4.777)
Obs	2737	3088	2622	2731	3083	2615
R^2	0.058	0.050	0.053	0.056	0.049	0.055

Panel B: SLOPE as dependent variable						
	Equal-weighted SLOPE			Value-weighted SLOPE		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
NIPO	4.128		4.347	-9.813		-9.479
	(0.609)		(0.621)	(-1.175)		(-1.141)
PVOL		0.308	0.196		0.111	0.132
		(0.500)	(0.309)		(0.125)	(0.129)
Intercept	-0.933	8.097***	-1.141	5.271	4.996*	1.406**
	(-0.169)	(3.642)	(-0.200)	(0.479)	(1.764)	(2.512)
Obs	2682	3016	2566	2685	3016	2569
R^2	0.030	0.029	0.030	0.007	0.006	0.007

This table reports the results of panel regressions which examine the relation between investor sentiment and the R&D effect on stock returns. The dependent variables are the monthly equal- and value-weighted spread (SPREAD) and slope (SLOPE). SPREAD is the equal-weighted or value-weighted average of the monthly return difference between the bottom and top R&D/BE quintile or tercile portfolios (High − Low), where their returns are cumulated from July of year t to June of year $t + 1$. The value-weighting of SPREAD is based on firms' market capitalizations in June of year t. SLOPE is given by regressing buy-and-hold stock returns from July of year t to June of year $t + 1$ on the R&D/BE measured over year $t - 1$. The regressions are either equal-weighted or value-weighted. The value-weighted version of SLOPE is based on weighted-least-squares regressions, where the weights are proportional to market capitalizations in June of year t. Panel A reports the regression results where the equal- or value-weighted SPREAD is used as the dependent variable. Panel B presents the regression results where the equal- or value-weighted SLOPE is used as the dependent variable. The explanatory variables include the number of newly listed equities (NIPO) and volatility premium (PVOL). The t-statistics reported in parentheses are computed using two-way clustered standard errors by country and year. Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Table 11: PVGO vs. limits-to-arbitrage and sentiments

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
			Panel A: EWSPREAD as dependent variable			
PVGO	0.095*	0.079	0.078	0.092*	0.097*	0.090*
	(1.807)	(1.494)	(1.434)	(1.739)	(1.939)	(1.713)
SHORT	0.309					0.666**
	(1.402)					(2.085)
IVOL		0.136				0.173
		(0.917)				(1.219)
DVOL			0.049			0.004
			(1.175)			(0.130)
NIPO				-0.061		-0.606
				(-0.037)		(-0.256)
PVOL					-0.017	-0.207
					(-0.156)	(-1.343)
Intercept	-1.248***	-0.924***	-0.378	-0.151	-0.591***	-0.682
	(-6.277)	(-2.605)	(.)	(-0.219)	(-8.667)	(-1.223)
Obs	2850	2467	2369	2715	3042	2171
R^2	0.058	0.060	0.062	0.059	0.052	0.058
			Panel B: VWSPREAD as dependent variable			
PVGO	0.054	0.052*	0.051*	0.055*	0.056*	0.066**
	(1.642)	(1.783)	(1.761)	(1.691)	(1.685)	(2.398)
SHORT	-0.129					0.356
	(-1.196)					(1.360)
IVOL		0.232**				0.236**
		(2.440)				(2.299)
DVOL			-0.016			-0.014
			(-0.413)			(-0.315)
NIPO				0.370		1.620
				(0.362)		(0.933)
PVOL					0.071	-0.034
					(0.406)	(-0.177)
Intercept	-0.523	0.589**	0.610***	-0.247	-0.563***	-1.177
	(-0.566)	(2.289)	(4.954)	(-0.685)	(-7.548)	(-1.410)
Obs	2850	2470	2367	2709	3038	2169
R^2	0.053	0.061	0.060	0.057	0.050	0.061
			Panel C: EWSLOPE as dependent variable			
PVGO	0.168	0.181	0.161	0.173	0.161	0.201
	(1.194)	(1.241)	(1.100)	(1.137)	(1.093)	(1.248)
SHORT	2.581*					4.988***
	(1.899)					(2.897)
IVOL		0.261				0.521**
		(0.788)				(2.126)
DVOL			0.141			-0.172

			(0.699)			(-0.846)
NIPO				4.253		0.815
				(0.616)		(0.128)
PVOL					0.290	-0.613
					(0.467)	(-1.015)
Intercept	-2.569*	-2.409***	2.974***	-0.908	-1.969***	-5.507
	(-1.712)	(-2.967)	(10.840)	(-0.558)	(-8.142)	(-1.507)
Obs	2791	2417	2323	2660	2970	2121
R^2	0.032	0.030	0.032	0.030	0.029	0.039
Panel D: VWSLOPE as dependent variable						
PVGO	0.458**	0.482**	0.450**	0.436**	0.461**	0.533**
	(2.205)	(2.235)	(2.060)	(2.133)	(2.104)	(2.277)
SHORT	3.369**					5.079***
	(1.981)					(3.279)
IVOL		-0.648				-0.367
		(-0.688)				(-0.502)
DVOL			0.446			0.130
			(1.333)			(0.459)
NIPO				-9.507		3.715
				(-1.140)		(0.501)
PVOL					0.091	-0.697
					(0.103)	(-0.676)
Intercept	-3.613*	-1.771	6.780***	4.952*	0.608*	-3.835
	(-1.924)	(-0.791)	(20.538)	(1.760)	(1.654)	(-1.094)
Obs	2791	2416	2321	2663	2971	2118
R^2	0.007	0.007	0.008	0.007	0.006	0.011

This table reports the results of panel regressions which examine the relation between investor sentiment and the R&D effect on stock returns. The dependent variables are the monthly equal- and value-weighted spread (SPREAD) and slope (SLOPE). SPREAD is the equal-weighted or value-weighted average of the monthly return difference between the bottom and top R&D/BE quintile or tercile portfolios (High − Low), where their returns are cumulated from July of year t to June of year $t + 1$. The value-weighting of SPREAD is based on firms' market capitalizations in June of year t. SLOPE is given by regressing buy-and-hold stock returns from July of year t to June of year $t + 1$ on the R&D/BE measured over year $t - 1$. The regressions are either equal-weighted or value-weighted. The value-weighted version of SLOPE is based on weighted-least-squares regressions, where the weights are proportional to market capitalizations in June of year t. Panel A reports the regression results where the equal- or value-weighted SPREAD is used as the dependent variable. Panel B presents the regression results where the equal- or value-weighted SLOPE is used as the dependent variable. The explanatory variables include the number of newly listed equities (NIPO) and volatility premium (PVOL). The t-statistics reported in parentheses are computed using two-way clustered standard errors by country and year. Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Table 12: PE vs. limits-to-arbitrage and sentiments

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Panel A: EWSPREAD as dependent variable						
PE	0.025**	0.020**	0.028***	0.025**	0.029***	0.025**
	(2.404)	(2.144)	(3.271)	(2.550)	(2.760)	(2.258)
SHORT	0.240					0.496
	(1.080)					(1.346)
IVOL		0.132				0.155
		(0.933)				(1.106)
DVOL			0.062			0.026
			(1.526)			(0.671)
NIPO				-0.017		-0.508
				(-0.012)		(-0.226)
PVOL					-0.058	-0.221
					(-0.494)	(-1.397)
Intercept	1.765**	0.463	-1.266***	-0.521	-0.928***	-0.596
	(2.149)	(1.316)	(-12.447)	(-0.826)	(-6.456)	(-1.039)
Obs	2839	2456	2358	2704	3031	2160
R^2	0.058	0.060	0.063	0.060	0.052	0.058
Panel B: VWSPREAD as dependent variable						
PE	0.023**	0.024**	0.027**	0.022**	0.028***	0.032**
	(2.397)	(2.239)	(2.091)	(2.362)	(2.641)	(2.200)
SHORT	-0.185*					0.150
	(-1.654)					(0.529)
IVOL		0.209**				0.191
		(2.195)				(1.630)
DVOL			-0.003			0.014
			(-0.076)			(0.334)
NIPO				0.420		1.866
				(0.419)		(1.081)
PVOL					0.034	-0.053
					(0.192)	(-0.286)
Intercept	1.551***	-0.148	-0.331	-0.577	-0.916***	-1.071
	(2.754)	(.)	(-1.614)	(-1.205)	(-6.103)	(-1.295)
Obs	2839	2459	2356	2698	3027	2158
R^2	0.054	0.061	0.061	0.057	0.051	0.062
Panel C: EWSLOPE as dependent variable						
PE	0.061	0.054	0.081	0.072*	0.074*	0.055
	(1.535)	(1.134)	(1.513)	(1.863)	(1.808)	(0.853)
SHORT	2.454*					4.708**
	(1.803)					(2.362)
IVOL		0.316				0.576*
		(0.885)				(1.868)
DVOL			0.194			-0.117

			(0.994)			(-0.464)
NIPO				4.501		0.889
				(0.712)		(0.147)
PVOL					0.167	-0.670
					(0.272)	(-1.166)
Intercept	4.992	-6.948***	1.945***	-1.966	-2.891***	-4.902***
	(.)	(-8.908)	(3.194)	(-1.226)	(-4.755)	(-3.687)
Obs	2780	2406	2312	2649	2959	2110
R^2	0.032	0.030	0.034	0.031	0.030	0.039
Panel D: VWSLOPE as dependent variable						
PE	-0.057	-0.014	-0.004	-0.055	-0.033	-0.018
	(-0.776)	(-0.230)	(-0.065)	(-0.788)	(-0.410)	(-0.242)
SHORT	3.394*					4.876***
	(1.887)					(3.411)
IVOL		-0.680				-0.389
		(-0.729)				(-0.550)
DVOL			0.436			0.112
			(1.367)			(0.417)
NIPO				-10.096		2.679
				(-1.224)		(0.385)
PVOL					0.140	-0.643
					(0.151)	(-0.612)
Intercept	-4.477	-1.068	-0.604	-0.645	1.379	-2.929
	(-1.186)	(-0.377)	(-0.183)	(-0.202)	(1.293)	(-0.417)
Obs	2781	2406	2311	2653	2961	2108
R^2	0.007	0.006	0.007	0.007	0.005	0.010

This table reports the results of panel regressions which examine the relation between investor sentiment and the R&D effect on stock returns. The dependent variables are the monthly equal- and value-weighted spread (SPREAD) and slope (SLOPE). SPREAD is the equal-weighted or value-weighted average of the monthly return difference between the bottom and top R&D/BE quintile or tercile portfolios (High − Low), where their returns are cumulated from July of year t to June of year $t+1$. The value-weighting of SPREAD is based on firms' market capitalizations in June of year t. SLOPE is given by regressing buy-and-hold stock returns from July of year t to June of year $t+1$ on the R&D/BE measured over year $t-1$. The regressions are either equal-weighted or value-weighted. The value-weighted version of SLOPE is based on weighted-least-squares regressions, where the weights are proportional to market capitalizations in June of year t. Panel A reports the regression results where the equal- or value-weighted SPREAD is used as the dependent variable. Panel B presents the regression results where the equal- or value-weighted SLOPE is used as the dependent variable. The explanatory variables include the number of newly listed equities (NIPO) and volatility premium (PVOL). The t-statistics reported in parentheses are computed using two-way clustered standard errors by country and year. Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Table 13: R&D intensity and future profitability

Panel A: All countries				
RD/BE	0.125***	0.115***	0.158***	0.079***
	(4.798)	(4.790)	(6.003)	(2.914)
PF_t	0.558***	0.545***	0.530***	0.484***
	(36.135)	(36.670)	(35.165)	(33.538)
ME				0.019***
				(22.095)
BM				-0.047***
				(-14.690)
MOM				0.112***
				(9.042)
Cty		Y	Y	Y
Ind			Y	Y
Obs	73477	73477	73477	72913
R^2	0.293	0.301	0.316	0.344
Panel B: Non-U.S.				
RD/BE	0.156***	0.152***	0.150***	0.094**
	(4.288)	(3.972)	(3.855)	(2.410)
PF_t	0.610***	0.590***	0.577***	0.551***
	(29.227)	(25.676)	(23.402)	(21.820)
ME				0.013***
				(6.668)
BM				-0.038***
				(-6.731)
MOM				0.077***
				(6.321)
Cty		Y	Y	Y
Ind			Y	Y
Obs	46477	46477	46477	46001
R^2	0.374	0.396	0.425	0.444

This table reports the time series averages and t-statistics of coefficients from cross sectional regressions of individual firms' operating profitability in year t+1 on R&D intensity in year t, operating profitability in year t+1, and control variables in year t, and country and industry fixed effects. Operating performance is defined as revenue minus cost of goods sold (COGS), interest expenses, and selling, general and administrative expenses (SG&A) scaled by book equity. Panel A reports the regression results for the whole sample, and Panel B for all countries excluding the U.S. The control variables include ME (the natural logarithm of June-end market value of year t), BM (the natural logarithm of the year $t-1$ fiscal year-end book-to-market ratio), and MOM (the year t January-to-May). The country/industry dummies are suppressed to save space. The t-statistics are adjusted for time-series autocorrelation and reported in the parentheses and significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 14: R&D intensity and market-to-book ratio

	Panel A1: All countries				Panel A2: Non-U.S.			
RD/BE	1.877***	1.550***	1.505***	1.169***	1.646***	1.635***	1.234***	1.246***
	(10.968)	(18.289)	(8.650)	(11.903)	(7.349)	(13.440)	(6.551)	(12.082)
PF_{t+1}	0.370***	0.415***			0.277***	0.365***		
	(8.811)	(12.953)			(5.662)	(8.540)		
ret_{t+1}	-0.279**	-0.188***	-0.235**	-0.156**	-0.361	-0.385***	-0.319	-0.359***
	(-2.603)	(-3.216)	(-2.200)	(-2.609)	(-1.696)	(-3.165)	(-1.490)	(-2.868)
$absPF_{t+1}$			0.658***	0.675***			0.671***	0.775***
			(12.309)	(14.952)			(8.154)	(10.526)
Cty		Y		Y		Y		Y
Ind		Y		Y		Y		Y
Obs	78191	78191	78191	78191	48656	48656	48656	48656
R^2	0.167	0.358	0.192	0.377	0.133	0.403	0.171	0.44

	Panel B1: All countries				Panel B2: Non-U.S.			
RD/ΔBE	0.006***	0.001	0.008***	0.003***	0.004	-0.001	0.006*	0.000
	(3.614)	(0.964)	(4.960)	(2.784)	(1.402)	(-0.396)	(1.862)	(-0.051)
PF_{t+1}	0.313***	0.394***			0.314***	0.418***		
	(7.451)	(13.223)			(6.095)	(7.360)		
ret_{t+1}	-0.328**	-0.197***	-0.259**	-0.157**	-0.538**	-0.434***	-0.451**	-0.385***
	(-2.410)	(-2.880)	(-2.072)	(-2.211)	(-2.720)	(-3.383)	(-2.344)	(-2.882)
$absPF_{t+1}$			0.897***	0.844***			0.885***	0.921***
			(12.455)	(17.620)			(8.511)	(14.184)
Cty		Y		Y		Y		Y
Ind		Y		Y		Y		Y
Obs	72760	72760	72760	72760	45133	45133	45133	45133
R^2	0.031	0.293	0.12	0.35	0.038	0.341	0.131	0.408

This table reports the time series averages and t-statistics of coefficients from cross sectional regressions of individual firms' market-to-book ratios in year t on R&D intensity in year t, control variables in year t, and country and industry fixed effects. Panel A reports the regression results with R&D/BE as independent variable, and Panel B reports the regression results with R&D/ΔBE as independent variable. The dependent variable, stock return, is measured at the first year holding horizon after June of year t. The control variables include operating profitability (pf), stock return (ret), and absolute value of operating profitability (abspf). The country/industry dummies are suppressed to save space. The t-statistics are adjusted for time-series autocorrelation and reported in the parentheses and significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 15: R&D intensity and future return volatility

			Panel A: All countries		
RD/BE	0.050***	0.058***	0.048***	0.044***	0.027***
	(7.053)	(8.979)	(7.652)	(6.858)	(5.251)
σ_t	0.412***	0.380***	0.355***	0.300***	0.285***
	(20.714)	(19.547)	(19.152)	(16.708)	(16.327)
ME				-0.009***	-0.008***
				(-14.361)	(-13.641)
BM				-0.002*	-0.001
				(-1.895)	(-1.005)
MOM				-0.018***	-0.017***
				(-4.897)	(-5.057)
ROE					-0.022***
					(-8.580)
AG					0.008***
					(9.420)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
Obs	103146	103146	103146	102543	98457
R^2	0.191	0.254	0.272	0.321	0.335
			Panel B: Non-U.S.		
RD/BE	0.025***	0.040***	0.033***	0.026***	0.013**
	(3.046)	(5.571)	(4.488)	(3.928)	(2.231)
σ_t	0.376***	0.312***	0.296***	0.261***	0.241***
	(13.121)	(15.608)	(14.994)	(12.136)	(11.644)
ME				-0.008***	-0.007***
				(-12.171)	(-12.468)
BM				-0.002**	-0.002*
				(-2.225)	(-1.851)
MOM				-0.016***	-0.015***
				(-3.545)	(-3.497)
ROE					-0.025***
					(-5.912)
AG					0.005*
					(1.994)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
Obs	68593	68593	68593	68112	64831
R^2	0.139	0.243	0.268	0.307	0.322

This table reports the time series averages and t-statistics of coefficients from cross sectional regressions of individual firms' stock return volatility in year t+1 on R&D intensity in year t, return volatility (σ) in year t, control variables in year t, and country and industry fixed effects. Panel A reports the results for all countries, and Panel B reports the results for all countries excluding the U.S. The dependent variable, monthly stock return volatility, is measured at the first year holding horizon after June of year t. The control variables include ME (the natural logarithm of June-end market value of year t), BM (the natural logarithm of the year $t-1$ fiscal year-end book-to-market ratio), MOM (the year t January-to-May), ROE (return on equity in year t), and AG (asset growth in year t). The country/industry dummies are suppressed to save space. The t-statistics are adjusted for time-series autocorrelation and reported in the parentheses and significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.