No. 01 (32) - 2025

# FINANCIAL CONSTRAINTS AND R&D INVESTMENT: INTERNATIONAL EVIDENCE

PhD. Le Quynh Lien*

**Abstract:** ***This study examines the impact of financial constraints on research and development (R&D) investment by analyzing data from 19,988 non-financial global firms from 2009 to 2023, drawn from the Global Compustat database. The analysis utilizes multiple regression techniques, including Pooled OLS, fixed-effects (FEM), and random-effects (REM) models, to assess the robustness of the findings. The results indicate that financial constraints, as measured by the Whited-Wu Index (WW), have a significant negative effect on both R&D intensity (RDEI) and the natural logarithm of R&D expenditure (LNRDE). Specifically, higher financial constraints are associated with a reduction in R&D investments, suggesting that firms experiencing financial difficulties tend to cut back on R&D spending. Additionally, while firm size negatively affects RDEI, indicating that larger firms invest less in R&D relative to their size, it positively influences LNRDE, suggesting that these firms, despite lower R&D intensity relative to their size, have higher absolute R&D expenditures. The analysis also reveals that cash flow does not significantly impact RDEI but negatively affects LNRDE. These results underscore the critical role of financial constraints in shaping firms' R&D investment strategies and highlight the complex relationship between firm size, financial constraints, and R&D expenditures.***

• Keywords: *financial constraints; R&D investment; global firms; compustat*

*JEL codes: G31, G32, O32*

*Date of receipt: 14th Nov., 2024*
*Date of delivery revision: 28th Nov., 2024*
*DOI: https://doi.org/10.71374/jfar.v25.i1.11*
*Date of receipt revision: 10th Dec., 2024*
*Date of approval: 02th Jan, 2025*

## 1. Introduction

Research and development (R&D) and innovation are difficult to finance due to market competition and constraints, which are driven by uncertainties in outcomes and asymmetric information between borrowers and lenders (Hall & Lerner, 2009). Investment decisions are influenced by both project evaluation and capital availability (Brown *et al.*, 2012), as R&D requires long-term investment before yielding results (Hall *et al.*, 1986). However, investors often prefer easily liquidated assets, making them hesitant to fund R&D (Stein, 2003; Alderson & Betker, 1996). This reluctance leads firms to scale back or abandon R&D projects in favor of lower-risk, quicker-return alternatives (Yang *et al.*, 2014).

As information asymmetry grows, companies become more reliant on internal cash flow for investment. The high risks of innovation create barriers to external financing, as firms hesitate to share information for fear of losing their competitive advantage (Aghion & Howitt, 1997).

Given these challenges, this study aims to investigate the impact of financial constraints on R&D investment. We analyze data from 19,988 non-financial firms over the period from 2009 to 2023. The paper is structured as follows: Section 1 introduces the research background and rationale for a global context. Section 2 reviews the literature and formulates the hypotheses. Section 3 details the research methodology and data. Section 4 presents the findings. Section 5 interprets the results, discusses limitations, suggests future research, and explores practical and theoretical implications.

## 2. Literature Review and hypothesis development

Corporate innovation, inherently risky (Liu *et al.*, 2017), increases cash flow uncertainty, impacting financial stability (Liu *et al.*, 2017). Cash flow stability is crucial for risk-taking and financing (Brown & Petersen, 2010). While some argue constraints stimulate innovation (Himmelberg & Petersen, 1994; Brown *et al.*, 2009), this study focuses on the negative impact of financial constraints on R&D investment.

These factors, including cash flow uncertainty and the critical need for stable cash flows to support risk-taking and innovation, underscore the significant impact of financial constraints on R&D investment (Tiwari *et al.*, 2008; Keefe & Tate, 2013; Boyle & Guthrie, 2003). Increased cash flow uncertainty leads to higher financing risks and reduced investment (Boyle & Guthrie, 2003). Information costs and cash flow dynamics also influence investment decisions (Hubbard, 1998).

Furthermore, innovation initiatives face significant financial constraints and uncertainty (Liu *et al.*, 2017),

** National Economics University; email: lienlq@neu.edu.vn*

requiring substantial funding. This is particularly evident in the case of Chinese firms, which heavily rely on internal financing but face a “financing gap” that hinders innovation (Beladi *et al.*, 2021).

Based on the literature review, the following hypothesis is proposed:

*H1. Financial constraints have a negative impact on R&D investment.*

## 3. Research methodology

### *3.1. Model specification and variables*

*3.1.1. The regression model*

Equation (1) is developed based on the literature review related to financial constraints and R&D investment as follows:

$$R\&D\ investment_{i,t} = \beta_0 + \beta_1 Financial\ constraints_{i,t} + \gamma Control_{i,t} + Year + \varepsilon_{i,t} \quad (1)$$

Where: R&D investment$_{i,t}$ is the proxy of R&D investment for firm i in year t; The key independent variable, Financial constraints$_{i,t}$ represents financial structure for firm i in year t; $\beta_0$, $\beta_1$ captures the impact of financial constraints on R&D investment. Control refers to the set of control variables described in Table 1.

*3.1.2. Independent variable*

The author uses the Whited-Wu (WW) index to quantify the level of financial constraints, as proposed by Whited and Wu (2006). It combines various financial ratios and firm characteristics to assess the extent of a firm’s financial constraints. To calculate the index, we use the following formula:

$$WW = 0.091 \times Cash\ Flow/Total\ Assets + 0.062 \times Long\text{-}term\ Debt/Total\ Assets - 0.021 \times Size + 0.044 \times Growth - 0.035 \times Capital\ Expenditure/Total\ Assets$$

Where:

Cash Flow/Total Assets: This term measures the firm’s liquidity. A higher cash flow relative to total assets indicates better liquidity, which is associated with lower financial constraints. The coefficient of -0.091 implies that higher liquidity (cash flow relative to assets) reduces the financial constraint score, reflecting less financial pressure.

Long-term Debt/Total Assets: This ratio represents the firm’s leverage. The positive coefficient of 0.062 suggests that greater leverage increases the WW index, indicating that higher levels of long-term debt are associated with higher financial constraints.

Size: This term is typically the natural logarithm of total assets. The coefficient of -0.021 indicates that larger firms tend to have fewer financial constraints. This is because larger firms usually have better access to financial resources and capital markets.

Growth: These variables measure the firm’s growth opportunities. The positive coefficient of 0.044 suggests that firms with higher growth opportunities might face more financial constraints, potentially due to the increased need for funding to support growth.

Capital Expenditure/Total Assets: This ratio reflects the firm’s investment in long-term assets. The negative coefficient of -0.035 indicates that higher capital expenditures relative to assets are associated with lower financial constraints, possibly because investment in assets can enhance future cash flows and reduce the firm’s financial constraints.

*3.1.3. Dependent variables*

Table 1 describes all the variables included in the regressions as follows:

**Table 1. Variable descriptions and descriptive statistics**

| Variable | Symbol | Description | References | Data source | Mean | Min | Max |
|---|---|---|---|---|---|---|---|
| **I. Dependent variables** | | | | | | | |
| R&D investment | RDEI | Research and Development expenditure/Total assets | Berchicci (2013), Usman et al. (2018) | Compustat | 0.0396 | 0.0000309 | 0.4995 |
| R&D investment | LNRDE | Natural logarithm of Research and Development expenditure | Giebel & Kraft (2024) | Compustat | 3.759 | -3.7297 | 11.0204 |
| **II. Independend variables** | | | | | | | |
| Financial constraints | WWI | Whited-Wu Index as a proxy of financial constraints | Chen et al. (2021) | Compustat | -0.0814 | -0.3302 | 5.2058 |
| **III. Control variables** | | | | | | | |
| Firm size | Size | Natural logarithm of Total assets | Usman et al. (2018) | Compustat | 7.5203 | -0.0325 | 15.9441 |
| Profitability | ROA | Net income/Total assets | Hutauruk, 2024 | Compustat | 0.0115 | -1.2128 | 0.3453 |
| Leverage | Lev | Total debt/Total assets | Gharbi et al. (2014) | | 0.5088 | 0.0063 | 2.5334 |
| Tangible assets | Tangible | Property, plant, and equipment/Total assets | Zwaferink (2019) | | 0.2571 | 0 | 0.9044 |
| Cash flow | Cash flow | Cash flow from operations | Wu et al. (2022) | | -0.0168 | -2.2334 | 1.1358 |

### *3.2. Sample and Methodology*

The author uses data from the Global Compustat database via WRDS, covering 19,988 non-financial firms from 2009 to 2023. Financial institutions were excluded due to their distinct financial activities. To ensure dataset quality, missing observations were removed, and winsorization was applied to trim the top and bottom 1% of observations, minimizing outlier influence. The final dataset includes 132,626 firm-year observations. Panel data was analyzed starting with a Pooled OLS regression, followed by tests for multicollinearity (VIF), heteroscedasticity (White test), and autocorrelation (Wooldridge test). To verify robustness, fixed-effects (FEM) and random-effects (REM) models were used, along with diagnostic tests for model specification issues.

## 4. Results and discussions

### *4.1. Summary statistics*

Table 1 presents descriptive statistics for the key variables in the study on financial constraints and R&D investment.

The mean R&D Expenditure Intensity (RDEI) is 0.0396, with a standard deviation of 0.0741, indicating that, on average, firms allocate a small portion of their resources to R&D, though there is considerable variability, with values ranging from nearly zero to 0.4995. The natural log of R&D Expenditure (LNRDE) has a mean of 3.759 and a standard deviation of 2.984, reflecting significant differences in R&D investment levels among firms, ranging from -3.7297 to 11.0204.

The Whited-Wu Index for financial constraints (WW) has a mean of -0.0814 and a high standard deviation of 0.5881, highlighting the wide variation in financial constraints experienced by firms, with values spanning from -0.3302 to 5.2058. Firm size, measured on a logarithmic scale, averages 7.5203 with a standard deviation of 3.3074, and ranges from -0.0325 to 15.9441, showing a broad spectrum of firm sizes.

Return on Assets (ROA) has an average value of 0.0115 and a standard deviation of 0.1958, indicating low average profitability but significant variation, with ROA values ranging from -1.2128 to 0.3453. The leverage ratio (Lev) averages 0.5088 with a standard deviation of 0.3592, demonstrating considerable variation in debt financing, from 0.0063 to 2.5334.

The proportion of tangible assets averages 0.2571 with a standard deviation of 0.2357, reflecting variability in asset composition, with values ranging from 0 to 0.9044. Finally, cash flow averages -0.0168 with a standard deviation of 0.3607, indicating slightly negative cash flow on average and a wide range from -2.2334 to 1.1358.

Table 2 displays the pairwise correlations among the variables analyzed.

**Table 2. Pairwise correlations**

| Variables | RDEI | LNRDE | WW | Size | ROA | Lev | Tangible | Cash flow |
|---|---|---|---|---|---|---|---|---|
| **RDEI** | 1.000 | | | | | | | |
| **LNRDE** | $0.010^{***}$ | 1.000 | | | | | | |
| **WW** | $0.048^{***}$ | $-0.041^{***}$ | 1.000 | | | | | |
| **Size** | $-0.380^{***}$ | $0.801^{***}$ | $-0.044^{***}$ | 1.000 | | | | |
| **ROA** | $-0.570^{***}$ | $0.170^{***}$ | $-0.035^{***}$ | $0.342^{***}$ | 1.000 | | | |
| **Lev** | $0.058^{***}$ | $-0.068^{***}$ | $0.022^{***}$ | $0.063^{***}$ | $-0.243^{***}$ | 1.000 | | |
| **Tangible** | $-0.263^{***}$ | $0.092^{***}$ | $-0.008^{***}$ | $0.091^{***}$ | $0.056^{***}$ | $0.005^{***}$ | 1.000 | |
| **Cash flow** | $-0.310^{***}$ | $0.111^{***}$ | $-0.050^{***}$ | $0.161^{***}$ | $0.501^{***}$ | $-0.056^{***}$ | $0.005^{***}$ | 1.000 |

*Notes: This table reports the pairwise correlation coefficient matrix of the variable used in this study. $^{***}$, $^{**}$ and $^{*}$ denote significant levels of 1, 5 and 10%, respectively*

The correlations are generally low, indicating minimal multicollinearity in the model. RDEI shows minimal correlations with other variables, suggesting its independence. LNRDE is strongly correlated with Size (0.801), indicating larger firms tend to have higher LNRDE, and weakly negatively correlated with ROA (-0.170). WW has low correlations with LNRDE (-0.041) and Size (-0.044), operating independently. Size is negatively correlated with ROA (-0.342) and positively with LNRDE (0.801), suggesting larger firms have lower ROA but higher LNRDE. ROA is positively correlated with Cash Flow (0.501). Lev shows weak correlations, with a slight negative relationship with ROA (-0.243). Tangible assets have weak positive correlations with LNRDE (0.092) and minimal links with other variables. Cash flow is positively correlated with ROA (0.501) and weakly with Size (0.161) and RDEI (-0.310). Overall, the correlations in Table 2 indicate weak to moderate relationships, confirming that multicollinearity is not a significant concern, allowing clearer interpretation of each variable's contribution.

### *4.2. Empirical results and discussions*

Table 3 presents the results of the multivariate regression analysis examining the impact of financial constraints and various control variables on two measures of R&D investment: R&D intensity (RDEI) and the natural logarithm of R&D expenditure (LNRDE). The table also includes the results of tests for fixed and random effects models to determine the most appropriate estimation approach for the analysis.

**Table 3. Analysis of multivariate regression results**

| VARIABLES | (1) | (2) | VIF |
|---|---|---|---|
| | RDEI | LNRDE | |
| **WW** | -0.001*** | -0.021*** | **1.01** |
| | (0.000) | (0.005) | |
| Size | -0.014*** | 0.782*** | 1.14 |
| | (0.000) | (0.006) | |
| ROA | -0.106*** | -0.740*** | 1.85 |
| | (0.003) | (0.037) | |
| Lev | 0.017*** | 0.057*** | 1.08 |
| | (0.001) | (0.019) | |
| Tangible | -0.005*** | 0.249*** | 1.09 |
| | (0.001) | (0.041) | |
| Cash flow | -0.001 | -0.056*** | 1.70 |
| | (0.001) | (0.013) | |
| Constant | -0.001*** | -0.021*** | |
| **Mean VIF** | (0.000) | (0.005) | **1.31** |
| R-squared | 0.297 | 0.677 | |
| **Tests for fixed and random effects** | | | |
| **White's test** | | | |
| Heteroskedasticity | 25892.92 (0.000) | 2134.44 (0.000) | |
| Skewness | 5887.67 (0.000) | 5147.53 (0.000) | |
| Kurtosis | 911.31 (0.000) | 837.43 (0.000) | |
| **Wooldridge test** | | | |
| | F(1, 15444) = 409.030 | F(1, 15439) = 1794.894 | |
| | Prob > F = 0.0000 | Prob > F = 0.0000 | |
| **Hausman test** | | | |
| | chi2(6) = 3963.95<br>Prob > chi2 = 0.0000 | chi2(6) = -24120.41<br>Prob > chi2 = 0.0000 | |

*Notes: This table reports the baseline regression results of the impact of financial constraints and R&D investment. The firm fixed effect is included in the regressions. Standard errors are double-clustered by firm-year. Robust t-statistics are in parentheses. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.*

Table 3 shows that the Whited-Wu Index (WW) negatively impacts RDEI and LNRDE, indicating that financial constraints discourage R&D investment. A higher Whited-Wu Index (WW) score indicates greater financial constraints, and the negative coefficients (-0.001 for RDEI and -0.021 for LNRDE) suggest that as financial constraints intensify, firms reduce both R&D intensity and total R&D expenditure. This supports H1 and aligns with the pecking order theory (Myers & Majluf, 1984), which posits that firms prioritize internal financing and scale back R&D when internal funds are limited. R&D, being costly and risky, is often deprioritized during financial stress as firms focus on short-term survival. Whited and Wu (2006) support this, explaining that constrained firms often redirect resources from R&D to immediate financial needs. Furthermore, agency theory (Jensen & Meckling, 1976) suggests that managers may prioritize short-term financial stability over risky R&D investments, potentially leading to underinvestment in innovation.

Firm size exhibits opposing effects on R&D investment. The negative coefficient for size in the RDEI model (-0.014) suggests that larger firms have lower R&D intensity, likely due to their established market positions, aligning with Baysinger and Hoskisson (1990). However, the positive coefficient for LNRDE (0.782) indicates that larger firms still allocate substantial absolute amounts to R&D. This supports the resource-based view (Barney, 1991), suggesting that large firms possess the resources to fund significant R&D investments despite lower relative intensity.

Table 3 shows a negative relationship between return on assets (ROA) and both RDEI and LNRDE, suggesting that more profitable firms may invest less in R&D. This finding may be explained by a focus on short-term profitability over long-term innovation. This aligns with Jensen's (1986) free cash flow theory, which suggests that firms with high profitability and excess cash may prioritize shareholder returns (e.g., dividends, share buybacks) or other short-term investments over potentially risky R&D expenditures.

Table 3 shows a positive effect of leverage (Lev) on both RDEI and LNRDE, indicating that firms with higher debt levels tend to invest more in R&D. This finding appears to support the debt-overhang theory (Myers, 1977), which suggests that highly leveraged firms may be incentivized to pursue risky projects like R&D to generate returns for debt repayment. However, it also aligns with the argument by Aghion *et al.* (2004) that debt can incentivize innovation by creating a stronger incentive for firms to improve their financial performance.

Table 3 shows a negative relationship between tangible assets and RDEI, indicating that firms with more tangible assets tend to have lower R&D intensity. This supports Caves (1998), who suggests such firms may rely more on existing resources and established technologies for growth. However, the positive effect of tangible assets on LNRDE (0.249) suggests that firms with higher tangible assets still allocate substantial absolute amounts to R&D, likely due to their greater financial capacity to fund large-scale R&D projects.

Table 3 shows that cash flow has no significant impact on RDEI but negatively affects LNRDE. This suggests that while cash flow may not significantly influence the relative intensity of R&D, it can reduce the overall amount invested in R&D. This finding aligns with agency theory (Jensen & Meckling, 1976), which suggests that managers may prioritize projects that better align with their own interests, such as short-term profitability or empire-building, over potentially risky R&D investments, especially when excess cash is available.

For White's test of heteroskedasticity, both models (RDEI and LNRDE) show significant results with p-values of 0.000, indicating the presence of heteroskedasticity. The values for heteroskedasticity are 25,892.92 for RDEI and 2,134.44 for LNRDE, respectively. The test also highlights significant issues of skewness and kurtosis in both models, further confirming non-normality in the residuals.

The Wooldridge test for autocorrelation in panel data yields highly significant results for both models, with F-statistics of 409.030 for RDEI and 1,794.894 for LNRDE, both having p-values of 0.000. This indicates the presence of autocorrelation in the panel data.

The Hausman test is used to determine whether the fixed effects model or the random effects model is more appropriate. For both RDEI and LNRDE, the chi-squared statistics are highly significant with p-values of 0.000 (chi2(6) = 3,963.95 for RDEI and chi2(6) = -24,120.41 for LNRDE). This suggests that the fixed effects model is preferred over the random effects model, as it better accounts for the unobserved heterogeneity in the data.

In Table 3, these tests confirm that heteroskedasticity, autocorrelation, and model specification issues exist, and the fixed effects model is the more suitable approach for analyzing the relationship between financial constraints and R&D investment in this study. These issues will be addressed by implementing FEM robust, as shown in the results of Table 4.

### *4.3. Sensitivity tests*

**Table 4. Alternative analysis regressions**

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | FEM | | REM | | FEM Robust | |
| | RDEI | LNRDE | RDEI | LNRDE | RDEI | LNRDE |
| **WW** | **-0.001***** | **-0.021***** | **0.000** | **-0.015***** | **-0.001***** | **-0.021***** |
| | **(0.000)** | **(0.004)** | **(0.000)** | **(0.004)** | **(0.000)** | **(0.005)** |
| Size | -0.014*** | 0.782*** | -0.008*** | 0.805*** | -0.014*** | 0.782*** |
| | (0.000) | (0.004) | (0.000) | (0.003) | (0.000) | (0.009) |
| ROA | -0.106*** | -0.740*** | -0.117*** | -0.931*** | -0.106*** | -0.740*** |
| | (0.001) | (0.028) | (0.001) | (0.027) | (0.005) | (0.046) |
| Lev | 0.017*** | 0.057*** | 0.015*** | -0.022 | 0.017*** | 0.057** |
| | (0.001) | (0.015) | (0.001) | (0.014) | (0.002) | (0.026) |
| Tangible | -0.005*** | 0.249*** | -0.014*** | -0.176*** | -0.005*** | 0.249*** |
| | (0.001) | (0.031) | (0.001) | (0.028) | (0.002) | (0.061) |
| Cash flow | -0.001*** | -0.056*** | -0.000 | -0.038*** | -0.001 | -0.056*** |
| | (0.000) | (0.009) | (0.000) | (0.009) | (0.001) | (0.015) |
| Constant | 0.145*** | -2.763*** | 0.100*** | -3.013*** | 0.145*** | -2.763*** |
| | (0.001) | (0.038) | (0.001) | (0.029) | (0.004) | (0.085) |
| Observations | 132,626 | 132,588 | 132,626 | 132,588 | 132,626 | 132,588 |
| R-squared | 0.191 | 0.242 | | | 0.191 | 0.242 |
| Number of firmid | 19,988 | 19,983 | 19,988 | 19,983 | 19,988 | 19,983 |

*Notes: This table reports the regression results of the baseline model (Equation (1) to (2)) using alternative analysis regressions. Robust t-statistics are reported in parentheses. *, **, and *** denote statistical significance of 10, 5, and 1% levels, respectively.*

Table 4 confirms the robustness of our findings. Across Fixed Effects Model (FEM), Random Effects Model (REM), and FEM with robust standard errors, the negative impact of financial constraints, measured by the Whited-Wu Index (WW), on both R&D intensity (RDEI) and R&D expenditure (LNRDE) remains consistent. This consistency across models suggests that the observed relationship between financial constraints and R&D investment is robust.

### 5. Conclusions and implications

This study examines the impact of financial constraints on R&D investment using data from 19,988 global non-financial firms. The results show that financial constraints, measured by the Whited-Wu Index (WW), negatively affect both R&D intensity (RDEI) and total R&D expenditure (LNRDE). Increased financial constraints lead to reduced R&D investments, supporting the pecking order theory, which suggests firms with limited internal financing prioritize other needs over R&D.

Larger firms exhibit lower R&D intensity relative to their size but allocate significant amounts to R&D in absolute terms. This suggests that, despite lower relative spending, larger firms continue substantial R&D efforts to maintain their competitive edge. Additionally, cash flow does not significantly impact RDEI but negatively affects LNRDE, indicating that cash flow influences total R&D spending but not its intensity.

These findings have important implications for both academic research and practical management. Policymakers and managers should recognize that financial constraints can hinder R&D, potentially affecting innovation and long-term growth. Firms facing financial difficulties may need alternative financing or strategic adjustments to sustain R&D efforts. Future research could further explore the interactions between financial constraints, cash flow, and R&D investment, as well as other factors influencing R&D decisions across different industries.

### References:

*Aghion, P., Dewatripont, M., & Rey, P. (2004). Corporate Governance, Competition Policy, and Industrial Policy. International Journal of Industrial Organization, 22(5), 569-591.*

*Aghion, P., & Howitt, P. (1997). Endogenous Growth Theory [MIT Press Books]. The MIT Press.*

*Alderson, M. J., & Betker, B. L. (1996). Liquidation Costs and Accounting Data. Financial Management, 25(2).*

*Baysinger, B. D., & Hoskisson, R. E. (1990). The Composition of Boards of Directors and Strategic Control: Effects on Corporate Strategy. Academy of Management Review, 15(1), 72-87.*

*Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. Journal of Management, 17(1), 99-120.*

*Beladi, H., Deng, J., & Hu, M. (2021). Cash flow uncertainty, financial constraints, and R&D investment. International Review of Financial Analysis, 76, 101785.*

*Berchicci, L. (2013). Towards an open R&D system: Internal R&D investment, external knowledge acquisition, and innovative performance. Research Policy, 42(1), 117–127.*

*Boyle, G. W., & Guthrie, G. A. (2003). Investment, Uncertainty, and Liquidity. The Journal of Finance, 58(5), 2143–2166.*

*Brown, J. R., Fazzari, S. M., & Petersen, B. C. (2009). Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom. The Journal of Finance, 64(1), 151–185.*

*Brown, J. R., Martinsson, G., & Petersen, B. C. (2012). Do financing constraints matter for R&D? European Economic Review, 56(8), 1512–1529.*

*Brown, J. R., & Petersen, B. C. (2010). Public entrants, public equity finance, and creative destruction. Journal of Banking & Finance, 34(5), 1077–1088.*

*Caves, R. E. (1998). Industrial Organization and New Findings on the Turnover and Mobility of Firms. Journal of Economic Literature, 36(4), 1947-1982.*

*Chen, C., Shi, S., Song, X., & Zheng, S. X. (2021). Financial constraints and cross-listing. Journal of International Financial Markets, Institutions, and Money, 71, 101290.*

*Gharbi, S., Sahut, J.-M., & Teulon, F. (2014). R&D investments and high-tech firms' stock return volatility. Technological Forecasting and Social Change, 88, 306–312.*

*Giebel, M., & Kraft, K. (2024). R&D investments under financing constraints. Industry and Innovation, 0(0), 1–28.*

*Hall, B. H., Griliches, Z., & Hausman, J. A. (1986). Patents and R and D: Is There a Lag? International Economic Review, 27(2), 265–283.*

*Hall, B., & Lerner, J. (2009). The Financing of R&D and Innovation. Handbook of the Economics of Innovation, 1.*

*Himmelberg, C. P., & Petersen, B. C. (1994). R & D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries. The Review of Economics and Statistics, 76(1), 38–51.*

*Hubbard, R. G. (1998). Capital-Market Imperfections and Investment. Journal of Economic Literature, 36(1), 193–225.*

*Hutauruk, M. R. (2024). The effect of R&D expenditures on firm value with firm size moderation in an Indonesia palm oil company. Cogent Business & Management, 11(1), 2317448.*

*Jensen, M. C., & Meckling, W. H. (1976). Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure. Journal of Financial Economics, 3(4), 305-360.*

*Jensen, M. C. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. American Economic Review, 76(2), 323-329.*

*Liu, B., Li, Z. S., Wang, H. L., & Yang, J. Q. (2017). Cash flow uncertainty and corporate innovation. Economic Research, 3, 166–180.*

*Myers, S. C. (1977). Determinants of Corporate Borrowing. Journal of Financial Economics, 5(2), 147-175.*

*Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. Journal of Financial Economics, 13(2), 187–221.*

*O'Connor Keefe, M., & Tate, J. (2013). Is the Relationship between Investment and Conditional Cash Flow Volatility Ambiguous, Asymmetric or Both? (SSRN Scholarly Paper 2189124). Social Science Research Network.*

*Whited, T. M., & Wu, G. (2006). Financial Constraints Risk. Review of Financial Studies, 19(2), 531-559.*

*Stein, J. (2003). Agency, information and corporate investment (pp. 111–165) [Handbook of the Economics of Finance]. Elsevier.*

*Tiwari, A. K., Mohnen, P., Palm, F. C., & van der Loeff, S. S. (2008). Financial Constraint and R&D Investment: Evidence from CIS. In C. van Beers, A. Kleinknecht, R. Ortt, & R. Verburg (Eds.), Determinants of Innovative Behaviour: A Firm's Internal Practices and its External Environment (pp. 217–242). Palgrave Macmillan UK.*

*Usman, M., Abid, A., Shaique, M., & Shaikh, S. A. (2018). R&D Investment, Terrorism and Firm Market Performance. Market Forces, 13(1).*

*Wu, X., Hua, Y., & Lu, H. (2022). The Influence Mechanism of Different Cash Flow Availability on R&D Investment: Evidence from China. Complexity, 2022(1), 7458978.*

*Yang, E., Ma, G., & Chu, J. (2014). The impact of financial constraints on firm R&D investments: Empirical evidence from China. International Journal of Technology Management, 65(1–4), 172–188.*

*Zwaferink, L. (2019). The impact of R&D investment on firm performance: A comparison of high- and non-high-tech SMEs. University of Twente.*