İŞLETME ARAŞTIRMALARI DERGİSİ
JOURNAL OF BUSINESS RESEARCH-TURK
2024, 16(1), 465-471
https://doi.org/10.20491/isarder.2024.1803

Firm-Level and Macroeconomic Determinants of R&D Investments in Turkey

Pınar OKAN GÖKTEN [a] **Türker AÇIKGÖZ** [b] **Soner GÖKTEN** [c]

[a] Ankara Hacı Bayram Veli University, Ankara, Türkiye. pinar.okan@hbv.edu.tr
[b] Baskent University, Ankara, Türkiye. turker.acikgoz1@gmail.com
[c] Baskent University, Ankara, Türkiye. sgokten@baskent.edu.tr

ARTICLE INFO

Keywords:
Innovation Management
Panel Data Analysis
R&D Investments

Received 13 January 2024
Revised 14 March 2024
Accepted 20 March 2024

Article Classification:
Research Article

ABSTRACT

Purpose – The purpose of this study is to examine firm-level and macroeconomic determinants of R&D investments in Turkey.

Design/Methodology/Approach – This study employs two groups of variables to explain R&D investments of publicly traded firms in Turkey. The first group contains firm-level financial indicators, containing liquidity, profitability, tangibility, productivity and financial leverage. The second group includes macroeconomic variables such as inflation rates, industrial production, economic growth, foreign trade and foreign direct investments. To exhibit the impact of two groups of factors, this study applies two panel data regression models.

Findings – The findings indicate that macroeconomic variables do not explain firm-level R&D investments. The only significant variable is inflation rates, which have an adverse effect on R&D decisions. On the other hand, firm-level financial variables explain the variation in R&D investments quite well. Liquidity and financial leverage significantly and positively influence innovation and research while profitability has a negative impact on them.

Discussion – The results indicate that firm-level R&D expenditures are mostly robust to macroeconomic conditions, while internal determinants are more significant in explaining R&D behavior.

1. INTRODUCTION

In the current economy centered on knowledge and driven by the growth of high-tech sectors, research and development has become a crucial component of competition at both firm and country levels. The significance of research and development (R&D) activities for both firm performance and overall economy is highlighted in the literature as well (Greenhalgh & Rogers, 2010). R&D activity constitutes a systematically organized process involving the creation, production, dissemination, and application of knowledge and this process encompasses innovations in scientific technology, managerial practices, as well as social and political systems (Wang, 2010).

Investing in R&D stands out as a critical component in advancing knowledge, enhancing productivity, and fostering overall growth. Therefore, R&D expenditures are a necessary condition for reaching potential growth and value creation. The previous literature has investigated R&D investments and their impact at the firm level and macroeconomic perspective. For firm-level analysis, Wakelin (2001) examined the interaction between the growth in productivity and R&D investments of manufacturing firms in the United Kingdom. The author showed the positive impact of R&D on firm-level productivity growth. The study of Lin, Lee, & Hung (2006) explores the US case and highlights that one of the major sources of competitive advantage for firms is R&D and it has become a crucial topic for high-tech industries. Further, Koellinger (2008) analyzed a sample of 7302 European firms to exhibit how R&D intense, technology-adapted and innovative firms diverge from others and how these factors influence firm performance. The results show positive benefits of the factors on firm performance at various levels.

The well-documented outcome in existing literature is the beneficial influence of research and development investments on both firm productivity and performance. Conversely, understanding the factors influencing R&D investments is a significant research question for both academia and practitioners. Thus, this paper conducts empirical analysis to explore the factors influencing research and development investments at the

Önerilen Atıf/Suggested Citation
Okan Gökten, P., Açıkgöz, T., Gökten, S. (2024). Firm-Level and Macroeconomic Determinants of R&D Investments in Turkey, *Journal of Business Research-Turk*, 16 (1), 465-471

firm level in Turkey. This paper examines a panel data of Turkish firms with consistently investing in R&D, spanning from 2010 to 2022. By utilizing panel data analysis methodology, both firm-level and macroeconomic determinants of R&D investments are investigated. The findings show that R&D investments are mostly unaffected by the macroeconomic state. On the other side, R&D investment decisions are mainly taken according to firm-level determinants.

2. LITERATURE REVIEW

In the literature review process, a limited number of studies were found that investigate the determinants of R&D investments at the firm level. The literature on firm-level R&D investment predominantly focuses on two main sets of variables. The first group is the firm-level characteristics, such as firm size, age, profitability, leverage, and liquidity, while the second set includes general economic variables, including economic growth, country characteristics, and development level. The following sections discuss the literature, sorted by date.

Lee (2012) examines R&D investments of Korean manufacturing firms with financial variables. Using panel data analysis, he demonstrates that R&D investments are highly sensitive to corporate debt and internal cash flows.

Lai, Lin, & Lin (2015) studied the internal factors affecting R&D investment decisions of Taiwanese, Japanese and Korean firms. The findings reveal divergent effects in different countries. While profitability affects R&D investments positively in Taiwan, this variable does not explain the R&D behavior of Japanese and Korean firms. Secondly, while financial autonomy is a positive determinant of R&D in Taiwan and Korea, it has a negative impact on R&D in Japan. Lastly, the authors exhibit that larger firms are more likely to invest in R&D.

Bragoli, Cortelezzi, & Marseguerra (2016) conducted a study on the determinants of R&D using capital structure and ownership structure in Italian firms. By employing panel data approaches, the researchers discovered a non-linear association between capital structure and the intensity of research and development. The findings indicate an inverse relationship: as the financial leverage ratio increases, firms tend to enhance their R&D intensity. A similar study is also conducted by Gupta (2019) on Indian companies. The author identified an inverse interaction between research and development investments and institutional ownership. Besides, Gupta (2019) confirms the previous study and shows that debt usage sustains R&D investments.

Xu & Sim (2018) examined the emerging markets of China and South Korea to exhibit which factors influence R&D intensity. The findings on panel data analysis show that debt maturity and liquidity are the factors that positively influence the intensity of research and development. While capital structure is the only firm-specific factor that negatively influences R&D in South Korean firms, Chinese companies' R&D decisions are negatively affected by firm size, internal financing and financial leverage.

Alam, Uddin, & Yazdifar (2019) considered the state-level institutional environment to explain firms' R&D investments. They used panel data from 20 emerging markets and applied the GMM model. The authors found that a country's institutional quality significantly boosts R&D investments. While government effectiveness, regularity quality, and the rule of law positively enhance R&D decisions, corruption, and political instability negatively impact R&D investments in emerging markets.

Neves & Branco (2020) investigate the factors influencing on the R&D investments of firms in high-tech industries. They used panel data of European firms and applied the GMM method. The authors show that R&D investments are significantly influenced by firm-level variables. While profitability, tangible and intangible assets adversely influence R&D, they define a positive relationship with equity to total asset ratio. On the other hand, the results show that liquidity have no significant impact on R&D decisions.

Liu, Li, He, & Hou (2021) investigate the factors influencing the research and development investments of R&D-intensive companies in China. The findings show that R&D intensive firms with high innovation efficiency tend to finance their R&D investments by liquidating operating and financial assets. Additionally, the analysis indicates that financially constrained firms face challenges in financing R&D investments and are adversely positioned compared to firms that can easily access financial resources.

Iqbal, Xu, Fareed, Wan, & Ma (2022) investigated the impact of financial leverage on corporate R&D decisions in Chinese firms. They utilized panel fixed-effect regression and system GMM approaches for data analytics. The findings imply that financial leverage hurts corporate innovation and R&D investments in China.

Curea, Ungureanu, & Mironiuc (2023) studied the R&D investments of the European pharmaceutical industry and tried to explain R&D expenses by using several macroeconomic, development, and firm-level variables. According to the results, firm-level variables of profitability and financial leverage have a negative impact on R&D. On the other side, the country's corruption level negatively affects R&D investments in the pharmaceutical industry. Lastly, the authors found that economic growth enhances R&D investments.

For the case of Turkey, Şenalp (2021) analyzed the firm-level determinants of R&D investments of Turkish manufacturing firms. By using panel data and probit model, the author found that firm size and firm age have a positive impact on R&D investments. Besides, the import and export activities as well as profitability are the factors enhancing R&D for manufacturing firms in Turkey.

3. RESEARCH METHODOLOGY

3.1. Dataset

This study investigates firm-level and macroeconomic determinants of R&D investments of firms in Turkey. The dataset of this study consists of 21 firms. The sample is selected according to following criteria. First, in order to achieve robust results, firms listed in XU100 index is obtained. After excluding the financial sector, the remaining sample was further filtered based on their persistence in R&D investments. Lastly, the firms who have been consistently conducted R&D activities for the sample period are selected as the sample of this study. The study uses panel data of 21 firms, spanning from 2010 to 2023. Therefore, the dataset comprises a total of 273 observations.

3.2. Econometric Models

In alignment with the research questions, the econometric research models are present in the following equations.

$$rd_{i,t} = \beta_0 + \beta_1 * liquidity_{i,t} + \beta_2 * roa_{i,t} + \beta_3 * ftta_{i,t} + \beta_4 * debt_{i,t} + \beta_5 * ato_{i,t} + \epsilon_{i,t} \quad (1)$$

$$rd_{i,t} = \alpha_0 + \alpha_1 * growth_t + \alpha_2 * cpi_t + \alpha_3 * fortrad_t + \alpha_4 * ipi_t + \alpha_5 * fdi_t + \mu_{i,t} \quad (2)$$

The first model in equation 1 examines R&D investments using firm-level financial variables. The second model in equation 2 investigates how macroeconomic variables influence R&D decisions.

The model variables given in the equations are explained as follows. First, for the dependent variable, R&D investments are measured with R&D intensity, which is the ratio of total R&D expenditures to total sales. Second, for firm-level financial variables, $liquidity_{i,t}$, $roa_{i,t}$, $ftta_{i,t}$, $debt_{i,t}$ and $ato_{i,t}$ represent liquidity, profitability (return on assets), tangibility, financial leverage and asset turnover ratio respectively, for firm i at time t. Third, for macroeconomic variables, $growth_t$, cpi_t, $fortrad_t$, ipi_t, and $fdi_{i,t}$ stand for GDP growth and natural logarithms of inflation rate, foreign trade, industrial production index and foreign direct investments at time t respectively. Lastly, $\epsilon_{i,t}$ and $\mu_{i,t}$ are the model residuals and are identically and independently distributed with zero means and constant variances such that $\epsilon \sim (0, \sigma)$, $\mu \sim (0, \tau)$.

3.3. Preliminary Analysis

In Table 1, descriptive statistics for research variables are presented. On average, Turkish firms exhibit a 0,6% R&D intensity with a standard deviation of 0,7%. In terms of liquidity positions, firms, on average, maintain a 1,05 liquidity ratio, indicating that most of them do not face difficulties in paying short-term debts. In terms of profitability and productivity, sample statistics reveal positive profitability and a 1,05 asset turnover ratio. Turning to capital structure, it is observed that, on average, Turkish firms finance their assets with 63.7% debt and 36.3% equity. For macroeconomic variables, it can be commented that Turkish economy have been expanding for the sample period. For instance, 6% average annual growth in the economy can be observed since 2010. Besides, macroeconomic variables show relatively low standard deviation from their means.

Table 1. Descriptive Statistics

	rd	liquidity	roa	ftta	debt	ato	cpi	ipi	growth	fdi	fortrad
Mean	0,0061	1,0506	0,0912	0,4401	0,6373	1,0151	0,1653	4,6613	0,0601	1,5085	12,9089
Median	0,0033	0,9600	0,0682	0,4516	0,6610	0,9400	0,1045	4,6544	0,0570	1,4435	12,8769
Std. Dev.	0,0070	0,4881	0,0983	0,1380	0,1670	0,5047	0,1583	0,1982	0,0327	0,2994	0,1656
Variance	0,0000	0,2383	0,0097	0,0190	0,0279	0,2547	0,0251	0,0393	0,0011	0,0897	0,0274
Kurtosis	5,1692	0,0981	5,8965	-0,5686	-0,1107	1,1081	3,7297	-1,0196	-0,7819	0,4728	1,4864
Skewness	2,1544	0,8320	1,9231	0,0819	-0,4763	0,9523	2,1833	0,0527	0,2359	0,8718	0,9381
Min.	0,0000	0,1700	-0,0987	0,1381	0,1335	0,1200	0,0616	4,3278	0,0070	1,0689	12,6096
Max.	0,0430	2,4900	0,6350	0,7921	0,9376	2,6900	0,6427	4,9754	0,1190	2,2287	13,3341
# of Obs.	273	273	273	273	273	273	273	273	273	273	273

The unconditional Pearson correlations are presented in Table 2. The R&D intensity has low correlation with most of the variables. While tangibility, inflation and economic growth perform negative correlation with R&D, the level of comovement is quiet low. On contrary, liquidity, profitability and financial leverage exhibit positive but low-degree correlation with R&D.

Table 2. Pearson Correlation Matrix

	rd	liquidity	roa	ftta	debt	ato	cpi	ipi	growth	fdi	fortrad
rd	1										
liquidity	0,053	1									
roa	0,032	0,33094	1								
ftta	-0,195	-0,2643	-0,354	1							
debt	0,087	-0,5643	-0,533	0,0972	1						
ato	0,005	-0,0452	0,3016	-0,32	-0,102	1					
cpi	-0,047	-0,0725	0,3259	-0,08	0,0885	0,019	1				
ipi	-0,008	-0,0286	0,2574	-0,041	0,1355	-0,09	0,714	1			
growth	-0,042	-0,0129	0,0386	-0,072	-0,02	0,083	0,119	-0,184	1		
fdi	-0,001	-0,0351	0,0237	0,0068	-0,008	0,054	-0,03	-0,152	0,3475	1	
fortrad	-0,028	-0,0702	0,2838	-0,05	0,089	0,021	0,874	0,7177	0,1158	-0,002	1

4. RESULTS AND DISCUSSION

In this part of the study, the research findings are discussed. Following the research questions, two econometric models are constructed and estimated with panel regression analysis. Table 3 below presents model estimation results. For parameter estimation, the Haussman test proposed by Hausman (1978) is utilized to choose between fixed effect or random effect models. The results of Haussman test indicate the superiority of random effect method for both models and therefore, the parameters are estimated with random effect method.

Table 3. Model Estimation

	Model 1	Model 2
Constant	0,0013	-0,0223
liquidity	0,0023***	
roa	-0,0050**	
ftta	-0,0001	
debt	0,0057**	
ato	-0,0007	
cpi		-0,0045**
ipi		0,0009
growth		-0,0071
fdi		0,0002
fortrad		0,0018
Haussman Test	Chi-square=1,005	Chi-square=1,50e-15
R2	9,50%	3,19%

Note: *** and ** symbolize 1% and 5% significance respectively

The first model investigates how firm-level financial variables influence R&D investments. The initial observation is that tangibility of the firm, proxied with fixed assets to total assets ratio, does not significantly impact R&D intensity. This suggests that R&D investments in Turkey are insensitive to fixed asset levels. Since these assets show the firm's capacity, it can be related with this idea. The study of Neves & Branco (2020) on the high-tech industries of European countries showed that tangibility has negative impact on R&D. When the firms have high level of tangibility, they tend to avoid spending resources on new innovations and research. However, for the Turkish case, it is found that firms do consider their R&D decisions regardless of their tangibility.

Considering asset turnover ratio, another financial performance ratio which proxy effectiveness of assets, this variable has no significant impact on R&D intensity. The firms' sales performance, standardized with total assets, do not explain why firms direct their resources to research and development.

Moving forward to significant variables, this study exhibits that profitability is a significant factor to explain R&D investments. The results show that firm profitability has significant impact on R&D behavior at 95% confidence level. The estimated parameter for this variable is negative, which indicates that the directional impact is adverse. While firms' profitability increase, it causes a downsizing in R&D investment. Firms with higher profitability tends to avoid research and innovation compared to others. It may be surprising that one could expect higher profitability and these excess resources are supposed to directed into R&D processes. However, it is not always the case. The literature has two different perspectives on the impact of profitability on R&D. Coad & Rao (2010) consider profitability as an important internal factor for R&D decisions. According to Liu et al. (2021), R&D processes occur under high uncertainty and require a large amount of financial resources with sustainable long-term support. Therefore, the authors state that profitability should be an essential determinant of R&D. On the other hand, I. H. Lee & Marvel (2009) and (Neves & Branco, 2020) reject the previous hypothesis and declare that higher profitability cannot always be related to R&D decisions. The empirical results also showed that profitability may hurt R&D investments. Similarly, Curea et al. (2023) confirmed these results for the European pharmaceutical industry.

The findings of this study support the second perspective by showing that R&D investments in Turkey are negatively influenced by profitability. This may be because when firms have high profitability, they become 'lazy' or 'slack off,' not exerting efforts for innovations and neglecting long-term targets. R&D investments occur as a result of long-term corporate strategies. While firms are faced with the costs of R&D today, the emergence of its benefits may take a very long time. Therefore, profitable firms may not choose to invest in R&D. Secondly, these firms may act conservative since they have sufficient results. Consequently, they may not consider future value-creation processes. The inverse of these two perspectives is also true for less profitable firms. Firms with low profitability tend to focus on R&D more than others. It may be called a "being in a tight spot" situation. When the firm has low profitability, it may consider fixing this problem by investing more in research and innovation for better future performance.

Another significant explanatory variable for R&D investments is liquidity position. The model results show that increasing liquidity ratio enhances R&D intensity. Firms with high liquidity tend to direct their excess cash positions into research and development processes. Conversely, when firms have low liquidity, they slow down their R&D processes.

The last firm-level factor is financial leverage. The model estimates that financial leverage positively influences R&D intensity. The literature also confirms these results. Bragoli et al. (2016) examined Italian firms' R&D behavior and showed that financial leverage significantly and positively impacts R&D intensity. Similar results are also obtained by Gupta (2019) on Indian firms. According to Bragoli et al. (2016), companies fund their research and development (R&D) efforts through debt, and as the intensity of R&D activities reaches a certain threshold, there is a tendency to replace debt with equity.

Moving the focus from firm-level financial variables to macroeconomic ones, inflation rates are the only variable that significantly explains R&D behavior. The results of model 2 show that economic growth, industrial production level, foreign direct investments, and foreign trade of the country are insufficient to explain the variation of firm-level R&D investments. Surprisingly, firms' R&D investment decisions are endogenous and insensitive to macroeconomic conditions. On the other hand, inflation rates are important for

research and innovation spending. The results show that inflation has a negative impact on R&D investments, and firms tend to avoid R&D expenditures during an inflationary environment.

5. CONCLUSION

Given the escalating globalization and spillover effects, firms operate in an increasingly risky environment and are compelled to seek solutions to navigate the competitive landscape. At this point, research and development plays a crucial role. R&D is the source of long-term sustainable corporate performance, competitive advantage, and continuous growth in corporate value.

Corporate R&D investments are important not only for firms but also for the aggregate economy. For today's modern capitalist economies, businesses are the economy's building blocks. So, R&D investments at the firm-level also enrich the country's economic performance and contribute to overall development. With the innovations and developments of products and services with researches, firms come up with high value-added productions, which eventually become the reason behind economic growth and development. So, for both firm-level success and country-level economic performance, the factors affecting R&D need to be understood comprehensively.

This study investigates firm-level and macroeconomic factors behind the motivation of R&D investments in Turkish publicly listed firms. For this purpose, two econometric models are estimated using panel regression analysis.

The results indicate that macroeconomic variables do not explain R&D investments of Turkish firms. Inflation is the only indicator influencing R&D expenditures, negatively impacting firms' innovation and research motivation. For firm-level financial analysis, the findings indicate that liquidity, financial leverage and profitability significantly explains the variation in R&D intensity. The model results show that profitability adversely impacts innovation and research, while liquidity position enhances it. Besides, it has been found that an increase in financial leverage also causes an increase in R&D intensity. This result is interpreted as companies financing their R&D investments through debt.

This study has important practical implications for policymakers, investors and managers. First, R&D is a long-run value-creation process that needs to be evaluated carefully. So, investors in financial markets may use the findings of this study and shape their long-term portfolio decisions by understanding how financial factors impact R&D. For managers, this study offers an understanding of R&D investments and how to manage these investments under several financial situations, such as liquidity position, profitability performance and capital structure decision. Lastly, as the study shows, R&D investments are highly and negatively influenced by inflation rates. Therefore, policymakers can encourage firm-level R&D by focusing on lower inflation rates via several actions such as monetary and fiscal policy.

This study has some limitations. The analysis is conducted only considering firms that have been persistently investing in R&D. On the other hand, firms that are cyclically embarking on R&D are excluded, and these firms may also offer valuable insights about innovation and research behavior of firms. Further studies can include abovementioned firms and provide more comprehensive results.

References

Alam, A., Uddin, M., & Yazdifar, H. (2019). Institutional determinants of R&D investment: Evidence from emerging markets. *Technological Forecasting and Social Change*, *138*, 34–44. https://doi.org/https://doi.org/10.1016/j.techfore.2018.08.007

Bragoli, D., Cortelezzi, F., & Marseguerra, G. (2016). R&D, capital structure and ownership concentration: evidence from Italian microdata. *Industry and Innovation*, *23*(3), 223–242. https://doi.org/10.1080/13662716.2016.1145573

Coad, A., & Rao, R. (2010). Firm growth and R&D expenditure. *Economics of Innovation and New Technology*, *19*(2), 127–145. https://doi.org/10.1080/10438590802472531

Curea, M., Ungureanu, I., & Mironiuc, M. (2023). Macroeconomic factors, liquidity issues, and research and development investments: empirical evidence from the EU pharmaceutical industry. *Eastern Journal of European Studies*, *14*(1), 261–283.

Greenhalgh, C., & Rogers, M. (2010). *Innovation, Intellectual Property, and Economic Growth*. Princeton University Press. https://doi.org/10.1515/9781400832231

Gupta, A. (2019). Capital structure, ownership structure and R&D investments: Evidence from Indian firms. *IUP Journal of Applied Finance*, *25*(1), 36–59.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, *46*(6), 1251–1271. https://doi.org/10.2307/1913827

Iqbal, N., Xu, J. F., Fareed, Z., Wan, G., & Ma, L. (2022). Financial leverage and corporate innovation in Chinese public-listed firms. *European Journal of Innovation Management*, *25*(1), 299–323. https://doi.org/10.1108/EJIM-04-2020-0161

Koellinger, P. (2008). The relationship between technology, innovation, and firm performance—Empirical evidence from e-business in Europe. *Research Policy*, *37*(8), 1317–1328. https://doi.org/https://doi.org/10.1016/j.respol.2008.04.024

Lai, Y.-L., Lin, F.-J., & Lin, Y.-H. (2015). Factors affecting firm's R&D investment decisions. *Journal of Business Research*, *68*(4), 840–844. https://doi.org/https://doi.org/10.1016/j.jbusres.2014.11.038

Lee, I. H., & Marvel, M. R. (2009). The moderating effects of home region orientation on R&D investment and international SME performance: Lessons from Korea. *European Management Journal*, *27*(5), 316–326. https://doi.org/https://doi.org/10.1016/j.emj.2009.04.011

Lee, S. (2012). Financial Determinants of Corporate R&D Investment in Korea. *Asian Economic Journal*, *26*(2), 119–135. https://doi.org/https://doi.org/10.1111/j.1467-8381.2012.02080.x

Lin, B.-W., Lee, Y., & Hung, S.-C. (2006). R&D intensity and commercialization orientation effects on financial performance. *Journal of Business Research*, *59*(6), 679–685. https://doi.org/https://doi.org/10.1016/j.jbusres.2006.01.002

Liu, D., Li, Z., He, H., & Hou, W. (2021). The determinants of R&D smoothing with asset sales: Evidence from R&D-intensive firms in China. *International Review of Economics & Finance*, *75*, 76–93. https://doi.org/https://doi.org/10.1016/j.iref.2021.03.013

Neves, M., & Branco, J. (2020). Determinants of R&D on European high technology industry: panel data evidence. *Management Research: Journal of the Iberoamerican Academy of Management*, *18*(3), 285–305. https://doi.org/10.1108/MRJIAM-11-2019-0969

Şenalp, U. E. (2021). Türkiye İmalat Sektöründe Ar-Ge Yatırımlarının Belirleyicileri. *Fiscaoeconomia*, *5*(3), 862–878. https://doi.org/10.25295/fsecon.943757

Wakelin, K. (2001). Productivity growth and R&D expenditure in UK manufacturing firms. *Research Policy*, *30*(7), 1079–1090. https://doi.org/https://doi.org/10.1016/S0048-7333(00)00136-0

Wang, E. C. (2010). Determinants of R&D investment: The Extreme-Bounds-Analysis approach applied to 26 OECD countries. *Research Policy*, *39*(1), 103–116. https://doi.org/https://doi.org/10.1016/j.respol.2009.11.010

Xu, J., & Sim, J.-W. (2018). Characteristics of Corporate R&D Investment in Emerging Markets: Evidence from Manufacturing Industry in China and South Korea. *Sustainability*, *10*(9). https://doi.org/10.3390/su10093002