



Impact of Environmental Regulations and Financial Restrictions on the Technological Innovation of Company

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Abstract

Objectives: Compliance with environmental regulations and financial resources is crucial for the survival of companies. Additionally, in a competitive market, paying attention to technological innovation is vital for companies. Therefore, the aim of this research is to investigate the impact of environmental regulations and financial constraints on technological innovation in companies.

Design/methodology/approach: This research is practical in nature and falls under post-event studies. A statistical sample of 124 firms listed on the Tehran Stock Exchange from 2018 to 2022 was selected using the screening method. Data analysis was conducted using a multivariate regression model with Eviews software.

Results: The results obtained indicated that environmental regulations and financial constraints have both an inverse and direct relationship with technological innovation in firms. In simpler terms, the more firms adhere to environmental regulations and financial constraints, the less technological innovation occurs within those companies.

Innovation: In the current era, focusing on technological innovation within companies is a crucial and impactful factor. Therefore, the innovative aspect of this research lies in the fact that there has been no prior research conducted on the correlation between environmental regulations, financial constraints, and technological innovation.

Keywords: Environmental regulations, Financial restrictions, Technological innovation.

1. Introduction

What differentiates companies and organizations today from those of a few decades ago is the unstable and complex environment, increased competition, rapid changes and developments, technological advances, the ever-growing development of communications, and rapid information exchanges. Undoubtedly, the changing environment of today does not allow organizations to be managed traditionally and permanently, despite the pressures from competitors' skills, abilities, and technologies. A key characteristic of successful organizations today is the power of innovation and the ability to leverage technological advancements. Technological innovation is crucial for organizational development, and neglecting it can lead to the failure of the organization (Tahmasabi Limoni, 2022).

The market's increasing competitiveness for products and services, the need to gain a competitive advantage, and the growing bargaining power of customers and suppliers are examples of external pressures that companies face. To survive in this environment, companies must exhibit adaptive behavior and respond to these pressures. Innovation, particularly in technological advancements, is undoubtedly the best and most effective response to these challenges in all organizational and operational aspects. Technological innovation can manifest in both processes and products. However, due to the rapid pace of environmental changes, accelerating and intensifying the organization's response through the identification and utilization of effective catalysts is essential. Catalysts and innovation drivers within companies are internal or external factors that directly or indirectly enhance technological innovations (Zarei and Ebrahimi, 2018).

Finances, as the cornerstone of modern economic development, play a crucial role in fostering innovation and company growth. Financial development, particularly strong financial support for research and development in science and technology, enhances production efficiency and directly impacts production. Access to information in advanced

financial markets or comprehensive financial systems is faster and more cost-effective, reducing external financing costs for companies and alleviating financial constraints. Conversely, in countries with slow or imperfect financial markets, firms may face financial constraints due to information asymmetry (Ge et al., 2020). A financial system dominated by banks may limit financing channels for companies, hindering successful entrepreneurship and economic growth in developing countries (Bormans and Willebrands, 2018).

Innovation not only influences national and global economies but also environmental protection. Monitoring environmental pollution from industrial activities, implementing government policies, and setting environmental regulations to promote and guide technology are essential. This research aims to explore the relationship between environmental regulations, financial constraints of companies, and technological innovation among those listed on the Tehran Stock Exchange. The study seeks to understand how environmental regulations and financial restrictions impact technology adoption and innovation within companies.

2. Theoretical foundations and research background

Technological innovation was first described by Schumpeter (1912) in five dimensions: new products, new methods of production, new technology, the opening of new markets, access to new raw materials, and new methods of organization (Nakamori, 2020).

Innovation is a process that begins with an idea. As the invention progresses, it undergoes significant changes, resulting in new products, processes, and services being introduced to the market. Companies strive to gain a competitive edge by providing added value to customers. To achieve this, they choose strategies such as price leadership, differentiation, orientation, and focus on differentiation (effective structures for innovation). Competitive strategies are obtained in various ways. Innovation is a rare resource that allows



companies to differentiate themselves from competitors (Namazi & Moghimi, 2018).

Tidd and Bessant (2014) classified innovations into four categories: product innovation, process innovation, positional innovation, and paradigm innovation. Technological innovation involves the creation of new technology and the development and introduction of products, processes, or services based on it (Hamidi & Benabdeljlil, 2015).

Enterprise innovation is a complex process that involves economic input and output, requiring significant investment in high-volume R&D. Sources of funding for research and development investment include domestic capital accumulation, government subsidies, and foreign funding. Financial limitations are mainly caused by information asymmetry. Research and development innovation activities are more sensitive to financial constraints compared to other investment activities due to the complexity and specificity of the innovation process, high risk, R&D activity accumulation, and uncertainty of innovation benefits (Jiang, 2015).

Innovation, as a major factor, plays a crucial role in creating value and enhancing business performance. Technological innovations are essential for business growth, improving the growth trajectory of many organizations and markets. Successful management involves skillfully allocating resources to drive technological changes that bring growth and wealth to an innovative organization. Developing appropriate policies to support innovation in economic institutions requires examining factors influencing companies' innovative efforts and their impact. Achieving and increasing technological innovations is crucial for all companies, regardless of size or industry. Technological innovation involves introducing methods or materials for operational and commercial purposes through a complex, long-term process involving searching, selecting, implementing, and creating value. It is a key factor in a company's competitive strength, essential for developing and maintaining a competitive advantage or entering new markets. Technological innovation can transform the

economic and political system within society, influencing external pressures. While much research has focused on identifying factors influencing innovation, external environmental pressures play a significant role in driving innovation (Zarei & Ebrahimi, 2018).

Environmental regulations

According to the standard view, strict environmental regulations affect productivity and competitiveness by imposing restrictions on the behavior of industries. Companies face direct costs such as technology, research, and development investments, necessary for reforming and restructuring production activities. Additionally, companies face indirect costs (opportunity costs) by accepting environmental regulations, as they cannot invest these incomes in other profitable opportunities. However, Porter (1991) challenged this view. He states that if a country applies stricter environmental regulations than its competitors, the promotion of innovations will cause that country to become a net exporter of new advanced environmental technologies (Azmi et al., 2017). Porter's hypothesis shows that well-designed environmental regulations can induce and facilitate technological innovation within companies, thereby strengthening business competitiveness (Costa-Campi et al., 2017).

Since entering the industrial society, many developed countries have experienced rapid economic growth; however, this "economic miracle" has been realized at a high cost to the environment. Developed countries competing for industrialization have observed similar problems, such as environmental pollution and ecological imbalance. Failure to pay attention to environmental considerations in development planning and implementation without studying the plans has had adverse environmental effects in many countries. Because of this neglect, the quality of the natural and human environment has greatly decreased, leading to the destruction of natural resources and public dissatisfaction. This issue is taking on wider dimensions in Iran, mainly because of the disregard for environmental laws. The



improvement of the environmental environment is mainly achieved through technical progress, process transformation, deep processing and comprehensive use, dust reduction, energy savings, emission reduction, and social monitoring. However, the theory of environmental modernization shows that environmental problems can be solved through technical progress carried out by government policies (Zho., 2015). While in the past, companies were seen as the main source of pollution, they are now increasingly seen as a possible solution, especially because of the potential of companies to act with innovative products. Resource-based perspectives show that positive participation in innovation activities can help companies improve their productivity and competitiveness; thus, companies also gain long-term competitive dominance.

2. Financial constraints

To categorize companies based on funding limitations, it is essential to first define financial constraints. The most comprehensive and clear definition in this context is that companies face financial constraints when there is a disparity between their internal costs and the external costs of obtaining funds. According to the Miller-Modigliani theory, there is no distinction in the cost of financing from internal or external sources for a company in a perfect capital market. In such circumstances, companies can acquire the necessary financial resources through the capital market seamlessly, with a certain capital cost rate (Rezaei, 2023).

One notable factor influencing a company's competitiveness is the financial constraints of economic enterprises. Financial limitations are a significant challenge that all companies encounter. Establishing and expanding economic enterprises necessitates substantial financial resources, which often exceed the founders' capabilities. In essence, companies have finite resources to draw upon, and they face constraints in obtaining financial support. These constraints impede access to the funds required to capitalize on investment opportunities, and

companies that struggle to access external financing are deemed to have financial limitations. Therefore, under this definition, all companies can be viewed as having financial constraints, but the severity of these limitations varies (Farji et al., 2019).

3. Background of the research

He et al. (2021) studied whether environmental regulations and financial constraints stimulate technological innovation in Chinese companies. The results showed that environmental regulations have a significant effect on technological innovation. Additionally, financial constraints mediate the relationship between environmental regulations and technological innovation. The moderating effect of financial constraints differs between environmental regulations and technological innovation.

Ge et al. (2020) investigated the relationship between environmental regulations, financial constraints, and green exports. The results showed that environmental regulations and financial restrictions have both positive and negative effects on green exports. However, the positive effect of environmental regulations does not fully offset the negative effect of financial restrictions, resulting in a net negative deviation from the effective level.

Debnath (2015) examined the relationship between environmental regulations and innovation in Nissan and Toyota companies. The results revealed that environmental regulations, typically introduced and enforced by the government, are perceived as threats by companies. Companies strive to understand and comply with new environmental standards, which often leads to increased costs. To offset these costs, companies choose to improve production processes or innovate by creating new products. This presents opportunities for companies to develop cost-effective production processes and environmental products.

Ford et al. (2014) explored the impact of environmental regulations on innovation in Australian oil and gas companies. The study found that new products/services and innovations necessitate compliance with new environmental regulations,



enhancing competitive skills and driving investment in research and development activities.

Salimifar et al. (2019) investigated the effect of quality management on green innovation with the moderating role of environmental regulations at Zagores Petrochemical. The research indicated that quality management initially hinders green technology innovation, but environmental regulations help mitigate this negative impact.

Rahimi et al. (2019) studied the effect of environmental commitment on green innovation and sustainable performance, with the moderating role of environmental education among employees at Mahshahr petrochemical companies. The results showed that environmental commitment positively influences green innovation, indirectly affecting sustainable performance. Green innovation, in turn, positively impacts sustainable performance, while environmental education did not play a moderating role in the study.

Bayat and Ebrahimi (2018) examined the financial situation and financing methods of companies and their impact on social and environmental reporting. The study revealed that companies with better financial status do not necessarily have higher levels of voluntary disclosure (social and environmental reporting index). Financing through debt, however, positively influences the level of voluntary disclosure, with the financial status of the company influencing the relationship between financing methods and disclosure levels.

Nazaripour and Mirzaei (2018) investigated the impact of strategic cost management, particularly environmental costs, on financial performance. The research showed that tracking environmental costs and implementing environmental initiatives significantly affect financial performance. Environmental executive cost management and environmental initiatives cost management are closely linked and jointly impact financial performance.

Azami et al. (2017) studied the impact of environmental regulations on the competitiveness of manufacturing industries in the United States,

England, and Canada. The results demonstrated that increased industry spending to reduce pollutants leads to more innovations, ultimately enhancing industry competitiveness. This supports Porter's hypothesis that environmental regulations positively affect industry competitiveness.

Dianti Deilmi and Khodakarmi (2017) analyzed the impact of environmental news on the stock prices of companies listed on the Tehran Stock Exchange. The research revealed that positive environmental news boosts stock prices and elicits a positive response from investors. Conversely, negative environmental news does not affect stock prices and results in a lack of investor reaction.

4. Research hypotheses

- 1) Environmental regulations affect technological innovation.
- 2) Financial restrictions affect technological innovation.

5. Research methodology

This research is applied in terms of purpose and descriptive correlational research in terms of nature. The field of post-event studies relies on actual information from the financial statements of companies listed on the Tehran Stock Exchange and other real data that can be generalized to the entire statistical population using an inductive method. Hypothesis testing was conducted using the Eviews software. The statistical population in this research includes all companies listed on the stock exchange that were active from 2018 to 2022. Additionally, the sample for investigation was selected using the screening method (systematic elimination) of 124 companies as a statistical sample.

5.1. Research variables

5.1.1. Dependent variable:

Technological Innovation of the Company (CTI): He et al. (2021) utilized the following equation to quantify the company's technological innovation. The data for



this variable was obtained from the explanatory notes of the company.

$$\text{Relationship (1)} \quad CTI = \frac{R\&D}{OP}$$

CTI: Corporate Technological Innovation
R&D: Cost of Research and Development
OP: Operating profit

5.1.2. Independent variables:

Environmental regulations

Based on the model presented by He et al. (2021), is shown to measure environmental regulations with the GDP/Energy ratio, which can measure the real effect of a set of environmental laws and regulations approved by the government. For this purpose, the ratio of gross domestic product to total final energy consumption was used as follows:

$$\text{Relationship (2)} \quad ER = \frac{GDP}{TEC}$$

ER: Environmental Regulation
GDP: gross domestic product
TEC: final energy consumption

Financial constraints

In this study, we followed the research conducted by He et al. (2021) and used the size and age index of companies to measure financial constraints. According to Hay et al., the higher the value of financial constraints, the lower the degree of financial constraints that the company faces. Therefore, the Financial Constraint (FC) index was calculated based on the size of the company using the natural logarithm of the total assets. As for the age of the company, the natural logarithm of the number of years since its establishment was used in the following relationship:

Relationship (3)

$$SA = 0.043 \times \text{Size}^2 - 0.737 \times \text{Size} - 0.04 \times \text{Age}$$

*SA value is negative.

FC=SA: financial constraint

Size: The size of the company

Age: Age of the company

Control variables:

Sales growth rate (S_GROWT): Sales in the current year minus sales in the previous year divided by sales in the previous year.

Return on assets (ROA): ratio of profit before extraordinary items divided by total assets.

Leverage ratio (the LEV): ratio of total debt to total assets.

5.2. Regression model of the research

The following multivariate regression model was used to test the research hypotheses:

Model (1)

$$CTI_{i,t} = \beta_0 + \beta_1 ER_{i,t} + \beta_2 S_{Growth_{i,t}} + \beta_3 ROA_{i,t} + \beta_4 LEV_{i,t} + \varepsilon_{i,t}$$

Model (1)

$$CTI_{i,t} = \beta_0 + \beta_1 FC_{i,t} + \beta_2 S_{Growth_{i,t}} + \beta_3 ROA_{i,t} + \beta_4 LEV_{i,t} + \varepsilon_{i,t}$$

6. Research findings

6.1. Descriptive statistics

Table No. (1) shows the descriptive statistics of research variables, including mean, median, maximum, minimum, and standard deviation.

Table 1. Descriptive statistics of the research variables

Variable	symbol	Average	Middle	Max	min	standard deviation	Number of views
Technological innovation	CTI	0.021291	0.0000	3.754639	0.00000	0.240212	620
Environmental regulations	ER	2.614058	2.718827	2.825653	2.267079	0.197670	620
Financial constraints	FC	3.139706-	3.319986-	1.481716	4.789316-	1.039929	620
Sales growth	GROWTH	0.265495	0.174729	6.594740	0.825557-	0.549212	620
leverage ratio	The LEV	0.537292	0.548307	0.986760	0.013863	0.191481	620
Return on assets	ROA	0.121279	0.098299	0.603493	0.297729-	0.134938	620



6.2. Inferential statistics

6.2.1 F test (Limer)

Table number (2) shows the results of the F-Limer of the model.

As can be seen in table number (2), at the 95% confidence level, the null hypothesis of the test has been rejected in the research models, so the panel data method should be used.

Table 2: Results of F (Limer)

Model	Null hypothesis (H0)	Statistic	d. f.	prob	Test result
1	Company-specific effects are not significant (Pooling method is suitable)	39.690720	(588, 123)	0.0000	H0 is rejected (the panel data method is selected)
2	Company-specific effects are not significant (Pooling method is suitable)	39.537392	(588, 123)	0.000	H0 is rejected (the panel data method is selected)

6.2.2 Hausman test

Table No. (3) shows the results of the Hausman test for choosing between fixed effects and random effect models.

Table 3. Hausman test results

Model	Null hypothesis (H0)	Chi-Sq. Statistic	Chi-Sq. d. f.	prob	Test result
1	The random effect method is suitable	2.649749	4	0.6180	H0 is accepted (the random effect method is suitable)
2	The random effect method is suitable	3.574553	4	0.4666	H0 is accepted (the random effect method is suitable)

6.2.3 Breusch-Pagan Variance Heterogeneity Test

Because the P-value listed in Table No. (4) of the models is less than the significance level of 5% and

has heterogeneity of variance. To solve this problem, the generalized least squares (GLS) method was used to estimate the model.

Table 4) The results of the heterogeneity of variance test of the research model

Model	statistics	prob	result
1	817.24	0.000	Variance heterogeneity
2	871.99	0.000	Variance heterogeneity

6.3 Hypotheses test

Hypothesis 1: Environmental regulations affect technological innovation.

Table number 5 displays the results of the estimation of the first research model. The F-test was utilized to determine the significance of the entire model. Based on the probability of the calculated F statistic (0.0000), the fitted regression model is deemed significant. The coefficient of determination of the fitted model indicates that approximately 82% of the changes in the dependent variable of the model (technological

innovation) are explained by the independent and control variables. Additionally, the Durbin-Watson test value of 1.824175 suggests the absence of autocorrelation among research variables and the appropriateness of the independence of model errors.

Upon examining the t statistic value, the variable of environmental regulation (-4.616285) demonstrates a negative and significant impact on the level of technological innovation of the company at a 5% error level. This is because its significance level is below the error rate of 0.05. Consequently, based on the results



obtained, it can be concluded that environmental regulations have a negative and significant effect on technological innovation.

Hypothesis 2: Financial limitations affect technological innovation.

Table 6 shows the results of the estimation of the first research model. The F-test was used to check the significance of the entire model. According to the Given the probability of the calculated F-statistic (0.0000), the fitted regression model is deemed significant. The coefficient of determination of the fitted model indicates that approximately 82% of the changes in the dependent variable (technological innovation) are explained by the independent and

control variables. Additionally, the Durbin-Watson test value of 1.819508 suggests the absence of autocorrelation between the variables and the appropriateness of the independence of errors in the research model.

Upon examining the t-statistic value, the financial constraint variable (2.307983) shows a positive and significant effect on the level of technological innovation of the company at a 5% error level. Its significance level is lower than the error rate of 0.05, indicating that financial limitations have a direct and significant effect on technological innovation.

Table 5: Summary of the statistical results of the model test (1)

Model (1)	$CTI_{it} = \beta_0 + \beta_1 ER_{it} + \beta_2 S_{Growth_{it}} + \beta_3 ROA_{it} + \beta_4 LEV_{it} + \epsilon_{it}$			
Variable	Coefficient	Std. Error	t-Statistic	Prob
C	0.159387	0.032804	4.858798	0.0000
ER	0.056573-	0.012255	4.616285-	0.0000
GROWTH	0.004749	0.002259	2.102596	0.0359
ROA	0.036691-	.011490	3.193299-	0.0015
The LEV	0.000675	0.007829	0.086158-	0.09314
CTI(-1)	1.001076	0.005153	194.2838	0.0000
(F-statistic)	545.1527	Durbin-Watson stat		1.824175
Prob	0.0000			
R-squared	0.823055	Adjusted R-squared		0.821545

Table 6: Summary of the statistical results of the model test (2)

Model (1)	$CTI_{it} = \beta_0 + \beta_1 ER_{it} + \beta_2 S_{Growth_{it}} + \beta_3 ROA_{it} + \beta_4 LEV_{it} + \epsilon_{it}$			
Variable	Coefficient	Std. Error	t-Statistic	Prob
C	0.020193	0.006919	2.918279	0.0037
FC	0.002772	0.001201	2.307983	0.0213
GROWTH	0.002868	0.002214	1.295402	0.1957
ROA	0.055174-	0.011550	4.776852-	0.0000
The LEV	0.004120-	0.007833	0.525935-	0.5991
CTI(-1)	0.999462	0.005148	194.1581	0.0000
(F-statistic)	545.1527	Durbin-Watson stat		1.819508
Prob	0.0000			
R-squared	0.823055	Adjusted R-squared		0.821201



7. Discussion and conclusion

As mentioned, this research investigates the impact of environmental regulations and financial restrictions on technological innovation in companies. The results of the first hypothesis test indicate that environmental regulations have a significant inverse effect on technological innovation. In other words, as a company's environmental regulations increase, its technological innovation decreases. Environmental policies and regulations are critical factors that influence organizational innovation. Therefore, compliance with environmental regulations can be costly for companies. If company managers anticipate a decrease in profits due to environmental regulations, they may opt for preventative measures to manage the company's environmental performance rather than taking a more dynamic and innovative approach based on the company's resources and capabilities.

Successful innovation largely depends on how effectively firms identify, seek, achieve, manage, and implement promising resources. Companies in different regions and industries face varying levels of environmental scrutiny. In some cases, firms with weak innovation capabilities rely more on technology introduction, imitation, or minute-by-minute management to avoid costs.

The results of the second hypothesis test reveal a significant direct impact of financial restrictions on technological innovation. In essence, the presence of financial restrictions hinders technological innovation in companies, reducing the costs associated with it. By prioritizing innovation, companies can leverage market opportunities to grow, succeed, and achieve better financial and economic performance. However, companies encounter significant challenges such as knowledge gaps and financial limitations while implementing innovation, which can impact their financial and economic performance.

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