Eco-Innovation as a Factor in Enhancing Firm Performance: Empirical Evidence from Tunisia

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Abstract

This study aims to investigate the impact of eco-innovation on environmental performance, economic performance, as well as the reputation of firms. Based on the theoretical and empirical literature on eco-innovation, we develop our research hypotheses and our conceptual model and then we test them in the Tunisian context. To do this, we conducted a survey of 159 industrial firms in Tunisia, divided into three groups as follows: a first group formed by 25 non-innovative firms, the second group includes 73 technologically innovative firms and a third group with 61 eco-innovative firms. We applied a principal component analysis and a multiple regression to the 61 companies having already achieved eco-innovations. The results show that eco-innovation has a significant impact on the environmental performance and reputation of companies. However, it does not directly improve economic performance.

Keywords: Eco-innovation; environmental performance; economic performance; corporate reputation; principal component analysis; multiple regression.

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1. Introduction

Nowadays, the world is plagued by climate change and global warming, caused by environmental pollution and harmful emissions from modern society (Cheng et al., 2022). Since the industrial revolution, anticipations in this area have highlighted the urgency of transition to a more rigorous natural resource management model in order to improve the well-being not only of present generations but also of future ones. Among the first actors concerned by this transition are companies that must be more aware and more vigilant face to the social, economic and environmental changes that the world has experienced in recent decades. These changes, on the one hand have caused excessive levels of pollution that in some cases exceed the absorption capacity of the environment. On the other hand, they have led to the impoverishment of the ecosystems due to irresponsible behaviour of extraction, production and consumption that generates the scarcity and even a severe shortage of resources.

According to a UNESCO report (2021)[1], the greatest concern facing the world today is to achieve a human development that is in harmony with the maintenance of the planetary balance. Today, the industrial firms contribute substantially to the economic development and, at the same time, harm the environment (Geng et al., 2021). In order to balance and improve their environmental and economic performance, some companies are implementing new environmental management practices, such as eco-innovation. This is an emerging concept, and it is a promising 'win-win' solution for industrial companies. Moreover, there seems to be a consensus among the academic and managerial communities that eco-innovations can play a fundamental role in both the economic and environmental fields.

The concept of eco-innovation first emerged in 1996 by Fussler and James entitled Driving Eco-innovation, and is related to the theme of sustainable development. Its objective is to sustainably limit or eliminate the negative impacts of socio-economic activities on ecosystems. The terms eco-innovation, environmental innovation, ecological innovation, green innovation or sustainable innovation have been used in the literature to identify innovations that contribute to a sustainable environment via the development of ecological improvements (Kemp and Foxon, 2007; Carrillo-Hermosilla et al., 2009; Halila and Rundquist, 2011; Xavier et al., 2017). The heavy use of these terms in various fields and by many scholars has resulted in a multitude of definitions that continue to evolve while keeping the idea of environmental protection. Andersen (2008) specifies that defining eco-innovation is a difficult exercise, on the one hand, given the complexity of the subject and, on the other hand, given the evolving and dynamic aspect of environmental concerns.

The term eco-innovation is composed of two words. The first, "eco", which is an abbreviation of the word ecological, and it means respect for the environment. The second, "innovation", is defined by the Oslo Manual as "the implementation of a new or significantly improved product or process, a new business method, or a new organizational method in the firm's practices, workplace organization, or relationships with its external environment" (OECD, 2005).

Kemp and Pearson (2007) define eco-innovation as "the production, the uptake or operation of a product, production process, service or business management, or organizational method that results throughout its life cycle in a reduction of environmental risks, pollution and other negative resource impacts (including energy use)".

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[1]UNESCO Report on Engineering for Sustainable Development. This report addresses the goals of sustainable development and shows how engineering can meet them. https://unesdoc.unesco.org/ark:/48223/pf0000375634_fre

The most important aspect of eco-innovation is that it aims to improve the long-term environmental performance of a company rather than just promoting operational efficiency and profit (Larbi-Siaw et al., 2023).

The empirical literature is still marked by the scarcity of works on eco-innovation in developing countries. The results on eco-innovation in one country cannot be systematically extrapolated to others. This can be explained by the heterogeneity of country characteristics, such as the level of environmental awareness of consumers and the behavior of business leaders, and by the state of development of the national innovation system (Del Río et al., 2016; Fernández et al. 2021).

This shows, the relevance of the new studies on eco-innovation investigating fields belonging to developing countries. Previous studies reveal that eco-innovation can bring improvements for both environmental and economic performances (Zhou et al., 2019). The objective of this study is to investigate the impact of eco-innovation on the performance of Tunisian firms in terms of environmental performance, economic performance and corporate reputation. In order to meet this objective we conducted a survey during the period 2018-2021 among 159 industrial firms, 61uniquely eco-innovating. The processing of the collected data was carried out by principal component analysis and multiple regression.

The article is organized as follows. The next section presents the theoretical framework and develops the research hypotheses. Section 3 describes the design of the questionnaire, the data collection and the characteristics of the sample it also presents the scales of measurement, the analysis of the validity and reliability of the variables. Section 4 is devoted to the discussion of the results. Section 5 presents the main conclusions, managerial recommendations, limitations and research perspectives.

2. Literature review and hypothesis development

In recent decades eco-innovation has been recognized as a source of competitive advantage on a world-wide scale (Almeida and Wasim., 2022).Companies that have successfully implemented eco-innovations have contributed to the preservation of nature and the development of beneficial social conditions for all human beings, which are collective benefits of eco-innovation. Nevertheless, each company expects individual benefits from the eco-innovation it has introduced, such as a positive effect on its environmental performance and/or economic performance.

Many studies have highlighted the role of eco-innovation in improving the environmental performance of firms (Geng et al., 2021; Costantini et al., 2017; Long et al., 2017; Cai and Li., 2018; Lee and Min., 2015; Fernando and Wah., 2017).Indeed, environmental performance indicates the ability of manufacturing plants to reduce air emissions, effluents and solid waste, as well as, the ability to reduce the consumption of hazardous and toxic materials (Zhu et al., 2008; Chien and Shih, 2007; Chiou et al., 2011).

Fernando and Wah (2017) point out that environmental performance can be defined in terms of three categories. The first: seeing the environmental impacts from polluting emissions and energy use is gradually reduced. The second: complying with environmental regulations. The last category, environmental, relates to organizational processes and capital expenditures. The literature combines these three categories to define environmental performance.

Environmental innovation can reduce environmental pollutants through the use of advanced production equipments and a clean production design, which can promote the economic development and the environmental protection. In addition, environmental innovation can have a positive impact on the environmental performance of enterprises (Frondel et al., 2010; Li, 2014).

Hence, the strengthening of environmental regulations will encourage firms to increase their R&D spending and to change the production processes. This can facilitate the environmental innovation. With the improvement of environmental innovation, clean production will increase and environmental pollutants will decrease, which improves the firm's environmental performance (Porter and Van Der Linde, 1995).

Taking account these elements, we formulate a first hypothesis:

Hypothesis 1 (H1): Eco-innovation has a positive impact on the firm's environmental performance.

In order to examine the relationship between eco-innovation and the economic performance of firms, we recall Porter's hypothesis (Porter, 1991; Porter and Van Der Linde, 1995) according to which a strict environmental regulation is able to encourage the eco-innovations allowing, as a result, to achieve "win-win" situations.

This leads to a better environmental and economic performance for firms. In contrast to the traditional economic view stipulating that the environmental regulation does not promote business competitiveness, Porter considers the environmental regulations as a source of profitability and competitiveness for companies.

As the literature indicates, eco-innovation is any product or process that aims to reduce the environmental impacts generated by companies. There are two categories of eco-innovations, which are eco-innovations imposed by the regulation and eco-innovations introduced voluntarily by firms. Eco-innovations are often likely to minimize environmental externalities by generating productivity gains either through improved efficiency in the use of resources or through increased ecological demand from consumers. These gains are likely to ensure that the high costs of eco-innovation are offset and subsequently increase the profits of eco-innovating firms (Rammer and Rexhauser, 2011).

In this sense, Porter and Van Der Linde (1995) argue that pollution is generally considered to be a waste of resources, and that reducing this waste improves the productivity of firms and subsequently their economic performance. The essential weakness of this argument is

that it ignores the distinction between internal and external costs to the firm. Companies generally pay more attention to controlling the costs, they incur than the costs they pass on to others.

To summarize, we can say that the voluntary environmental commitment of companies is explained by the expected long-term benefits, since each company targets the maximization of its profits and its competitiveness. In other words, if the stimulus for eco-innovation is not the anticipation of stricter regulations, it must be the anticipation of a better economic performance (Ambec and Lanoie, 2009). However, Ramathan et al (2010) pointed out that eco-innovation can have a negative influence on financial performance in the short term. Horvàthovà (2012) added that this negative effect is followed by a positive effect on the financial state of the company later on. So, the financial situation of an eco-innovative company in the short term is not ideal. But with the return on investment in the medium and long terms, the company begins to reap the benefits of eco-innovation. It should not be forgotten that it is not only the period of time that counts but also the type of eco-innovation which influences the firm's performance is as important.

The impact of environmental management (including eco-innovations) on the firm performance has also been recognized since the seminal work of Porter and Van der Linde (1995). Several publications have clearly confirmed the links between proactive environmental strategy (including innovation) and firm performance (see among others Christmann 2000, Klassen and Wybark 1999, Marcus and Geffen, 1998). All have found positive associations between process and/or product innovations and firm performance. Similarly, Clemens (2006) and Zeng et al, (2011) have highlighted that eco-innovation has a significant and positive impact on firm performance.

Along these lines, Doran and Ryan (2012) find that firms that implement process eco-innovation enjoy a higher level of revenue per employee than firms that do not. Similarly, the research focusing on product, process, and organizational eco-innovation has also found a positive influence of these eco-innovations on firm performance (Cheng and Shiu, 2012). The results of the works of (Ghisetti and Rennings, 2014; Rexhauser and Rammer, 2013) show that eco-innovations that rationalize the consumption of raw materials and/or energy exert positive and significant effects on firm profitability and competitiveness.

On this basis we formulate a second hypothesis:

Hypothesis 2 (H2): Eco-innovation has a positive impact on the firm's economic performance in terms of growth and profitability.
The impact caused by firms on the environment reflects in their market of operation and influences public opinion regarding the image of an organization. As a result, firms have started to integrate the environmental aspect into their business strategy and invest in practices that reduce the impact of their activities which cause ecological concerns. This point of view is also supported by Alam & Islam (2021) who argue that investing in sustainable practices has a positive effect on creating and enhancing corporate imageof firms (Almeida and Wasim., 2022).

A strong corporate reputation can enhance public trust, reduce stakeholder uncertainty, improve competitive position and defend the organization in times of crisis or threat (Fombrun 1996). However, damage to corporate reputation can be more costly than almost any other risk (Jackson 2004).

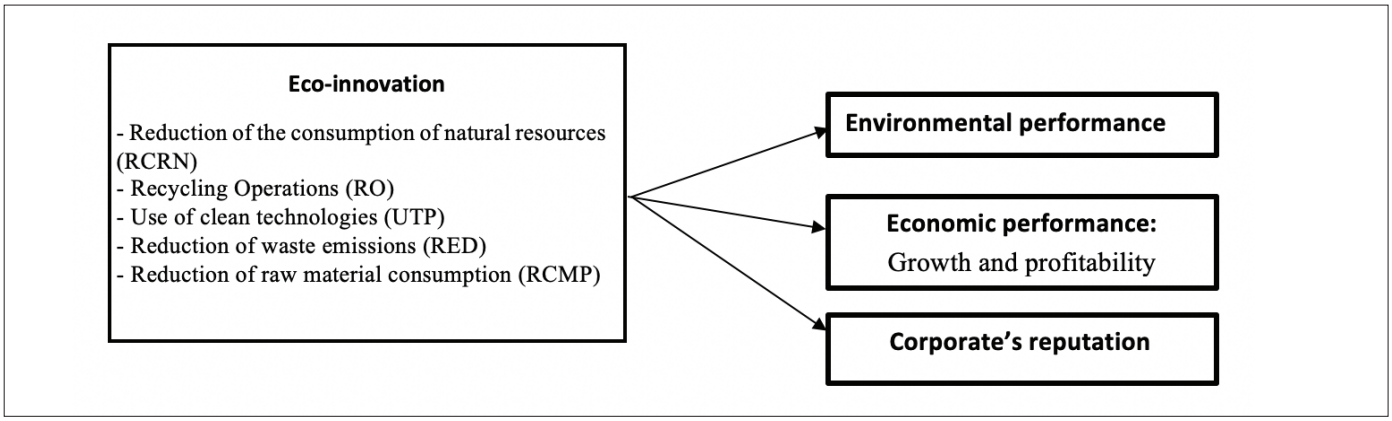
Today, eco-innovation has become a lever for improving and strengthening corporate reputation. In fact, corporate reputation is a composite performance resulting from the improvement of all past behaviors and results of a company. It describes its ability to provide a value output to various stakeholders (Fombrun, 1996). It is an intangible capital for companies and their key when they enter the market and seek the development and acquisition of competitive advantages. Moreover, with the public awareness of environmental protection, the environmentalist behavior of companies is attracting more and more attention. Eco-innovation can reduce environmental impacts, and the sources of pollution, and enable companies to achieve a better environmental performance than the industry average. Environmental innovation limits responsibilities of companies towards consumers, of internal staff, shareholders and of environment. If firms embrace eco-innovation, they can meet the environmental protection expectations expressed by various parties, including local governments and employees (Hojnik and Ruzzier, 2016).

This has the effect of reducing environmental risks and thereby improving the public image of firms. In addition, environmental innovation can bring to customers substantial benefits, such as energy conservation, energy savings, and improved health and safety, which can subsequently improve the reputation of firms.

Based on the above literature, the following hypothesis is made

Hypothesis 3 (H3): Eco-innovation has a positive effect on corporate reputation.
The above three hypotheses form our conceptual model of the relationships between eco-innovation and environmental performance, economic performance and corporate reputation illustrated in Fig. 1.

Fig. 1: Conceptual model of the relationship between eco-innovation and performances



3. Data and methodology

3.1 Content of the questionnaire

Our questionnaire was designed to collect information relating to the impact of eco-innovation on the environmental performance, economic performance and reputation of companies. It is composed of 13 general questions on the basic information of a company and 3 specific questions on eco-innovation behavior (see appendix). The development of items to measure each of the variables in our conceptual model is detailed in Table 1.

Table 1
Item development

Variables	Number of items	Sources of items
Eco-innovation	5	Chen et al. (2006)
Environnemental performance	6	Long et al. (2017) Ghazilla (2015) Li (2014)
Economic performance	3	Cheng et al. (2014) Hojnik et Ruzzier, (2016)
Corporate's reputation	3	Shrivastava, (1995) Vidaver-Cohen et Brønn, (2015) Schwaiger (2004) Sarkar (2013)

3.2 Data collection

To ensure the validity of the questionnaire, 6 teacher-researchers from Tunisia and France examined and commented on the clarity, readability, structure and relevance of the questions and items used. Then, interviews were conducted with 7 managers of Tunisian industrial companies for a pretest of the questionnaire. With the help of the comments provided by these teacher-researchers and company managers, we were able to make modifications and improvements to the questionnaire in order to improve its clarity.

At the first contact with the directors and managers of the companies, who often are quality, health, safety and environment engineers or senior managers, we began by explaining the context and the objectives of the study. If the person interviewed was not able to answer the entire questionnaire (not being the most knowledgeable person in the company), we asked the person contacted to forward the questionnaire to the most appropriate person in the company or to introduce this person to us so that we could complete the survey.

3.3 Characteristics of the sample

The characteristics of the sample of 61 eco-innovative firms are presented in Table 2. Our sample, according to the standards of the national business directory in Tunisia, includes 20 small firms (10 to 49 employees), 35 medium-sized firms (50 to 249 employees) and 6 large firms (250 employees and more). Most of the firms in our sample are independent firms (42 firms), 17 firms are group subsidiaries and 2 firms are group heads.

As for the sectors of activity, companies operate as follows: agri-food (12 companies), building materials (2 companies), mechanics and metallurgical (7 companies), electricity and electronics (1 company), chemistry (13 companies), textile and clothing (2 companies), wood, cork and furniture (9 companies) and various industries (15 companies). The majority of the companies included in our sample have transactions with foreign markets through exports - 47 exporting companies against 14 non-exporting companies. As for certifications, our sample contains 34 firms with ISO14001 environmental certifications and 47 firms which ISO9001 quality certificates.

Table 2
Characteristics of the sample

Characteristics		Number of firms	Percentage of firms
Type of firm	Independent company	42	69%
	Group subsidiary	17	28%
	Head of group	2	3%
Size of firm	Small company	20	33%
	Medium-sized company	35	57%
	Large company	6	10%
Sectors of activity	Manufacture of food products Manufacture of building	12	20%
	Mechanical and metallurgical	2	3%
	Electrical and electronic	7	11%
	Chemistry	1	2%
	Textiles and clothing	13	21%
	Wood, cork and furniture	2	3%
	Miscellaneous industries	9	15%
		15	25%
Internationalization	Open to foreign markets	47	77%
	Openonly to the national market	14	23%
Certifications	ISO9001	47	77%
	IS14001	34	56%

3.4. Measurement scales

The model variables: eco-innovation, environmental performance, economic performance and reputation were measured by items from the empirical literature. Data were generally collected using a Likert-type scale. Respondents completed the questionnaire by selecting a single option from the five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

3.5 Reliability and Validity Analysis

We have conducted a principal component analysis with SPSS software version 26 for the three variables: environmental performance, economic performance and reputation. The objective of this step is to synthesize the information from these items into a single factor that allows us to restore the maximum amount of initial information. We have used a Varimax rotation toartificially improve the correlation of items that are poorly correlated with their axes. As a result, we haven't retained all of the items originally presented in the questionnaire. Table 3 summarizes the items retained for further analysis and it reports all measurement items: the Kaiser-Meyer-Olkin (KMO) indices, the total explained variance, and the Cronbach's alpha values. The Cronbach's alphas for the variables in our study are greater than 0.7, indicating a high reliability of the questionnaire (Wortzel, 1979).In addition, all factor loadings were greater than 0.5, indicating a high convergent validity.

Table 3
Item measures, KMO index, total explained variances, and Cronbach's Alphas for the model variables.

Item measures	KMO Index	Total explained variances	Cronbach's Alphas
Environmentalperformance **EP1**: Your company has recorded a reduction in waste emissions (solid, liquid, gaseous) after the implementation of eco-innovations **EP2**: Your company has reduced the use of harmful/toxic hazardous materials through eco-innovations **EP3**: Your company has succeeded in making savings in the consumption of natural resources (energy, water, etc.) **EP4** : Thanks to its environmentally friendly practices, your company has recorded a decrease in expenses related to the consumption of raw materials supplied **EP5**: On average, your company's overall environmental performance has improved over the last five years compared to that of your competitors.	0.661	58.867	0.816
Economic performance **ECP1** :Your company has recorded a continuous increase in the number of employees as a result of eco-innovative activities in recent years **ECP2** :Your environmental innovations have significantly improved your market share **ECP3** :Your company has recorded an increase in performance as a result of its eco-innovative initiatives in recent years	0.607	65.185	0.714
Reputation **PR1**: Your company's environmental commitment generates positive sentiment from your stakeholders **PR2**: Your company's environmental commitment has a positive impact on the intensity of user confidence in your innovative products **PR3**: Your company is respected in its environment because of its environmental commitment	0.658	68.488	0.770

4. Results and discussion

The multiple regression (MR) is a statistical method whose objective is to study the relationship between a dependent variable and one or more independent variables. It is considered among the most widely used statistics in the social sciences but also in the biological and physical sciences (Allison, 1999). We consider each component of eco-innovation an independent variable and test their impact on the three dependent variables. Our three models to be tested are:

- Effect of eco-innovation on environmental performance (model 1)
- Effect of eco-innovation on economic performance in terms of growth and profitability (model 2)
- Effect of eco-innovation on reputation (model 3)

Table 4

Result of model 1: effect of eco-innovation on environmental performance

Variables	Coefficients	T-statistics	Significance
Constant	-4 .893	-15.732	0.000***
RCRN	0.370	4.956	0.000***
OR	0.109	1.680	0.099*
UTP	0.165	2.471	0.017**
RED	0.414	6.080	0.000***
RCMP	0.252	3.994	0.000***
R-deux	0.863		
R^2ajusté	0.850		
F-statistique	69.012		
Significativité	0.000***		

*** : significant at 1% level; ** : significant at 5% level; * : significant at 10% level

From the above table we can derive the following multiple regression equation:

Y = 0.370 (RCRN) + 0.109 (OR) + 0.165 (UTP) + 0.414 (RED)+ 0, 252 (RCMP) - 4.893

According to table 4, we note that the multiple regression results show that this model is important in explaining environmental performance. Indeed, the explanatory power of the model is high (adjusted R-two being equal to 0.850). Fisher's F-statistic is used to determine the overall significance of the model and to verify if there is a significant relationship between the dependent variable (environmental performance) and the independent variable (eco-innovation). We have obtained an F= 69.012 with $p < 1\%$, which allows us to reject the null hypothesis that the coefficients are all zero.

The results of this model show that 86.3% of the variation in the environmental performance of the industrial companies in the sample is explained by the adoption of eco-innovation. This allows us to conclude that the model is statistically significant and that it explains the phenomenon studied.

As for the results of the multiple regression, they indicate that the adoption and / or development of eco-innovations by companies affects positively and significantly the environmental performance of Tunisian industrial firms. Indeed, as shown in Table 4, all coefficients of the regression of the 5 components of the eco-innovation variable are positive and significant. This empirical finding allows us to accept the first hypothesis (H1).

The eco-innovation that has the most direct impact on the environmental performance of the company corresponds to the process eco-innovation. It is materialized by the integration of clean technologies, the multiplication of recycling operations, the implementation of wastewater treatment plants, the use of a less energy-consuming production apparatus, the use of renewable energies, the design of ecological packaging, a strategy of monitoring against environmental accidents, the minimization or even the elimination of polluting materials during the production process, ... The companies surveyed use at least one of these practices, which allows them to reduce waste emissions generated during the production cycle and reduce the use of harmful materials and this consequently, limits the occurrence of environmental accidents.

According to the table above, the eco-innovation component "your production processes have generated the reduction of emissions and waste" (RED) has the greatest impact on improving environmental performance. Indeed, the rigorous monitoring of polluting emissions (solid, liquid and atmospheric) during the production process allows the company to respect the tolerable discharge thresholds and to improve its overall environmental performance.

The eco-innovation component "you have reduced the consumption of energy, water, oil during the production process" (RCRN) presents the second important effect related to environmental performance. The consumption of natural resources such as water, energy ... is a key indicator for measuring environmental performance in any industry

especially in Tunisia. According to the indicators[2] published by the World Bank show that Tunisia is a country heavily dependent on fossil fuels. In addition, the annual volume of renewable freshwater resources amounted, in 2014, to 379 m^3/ inhabitant, that is to say a level largely lower than those found in high-income countries (8872 m^3/ inhabitant) and in middle-income countries (5477 m^3/ inhabitant). The results of our survey show that the companies surveyed are aware of and responsive to this alarming situation by adopting eco-innovative practices to rationalize the consumption of natural resources. The "Reduced Raw Material Consumption" (RCMP) component comes third in explaining environmental performance. Less consumption of raw materials results in less waste in terms of resources and consequently less waste generated, which results in improved environmental performance.

The "use of clean technologies" (UTP) component also allows the reduction of polluting emissions, of energy and raw materials, as well as an improved environmental performance of the company.

The component "Recycling Operations" (RO) has the lowest contribution to the explanation of environmental performance. This can be justified by the existence of many factors such as the scarcity of companies specializing in the treatment of specific wastes in Tunisia, and the non-generalization of recycling practices throughout Tunisian industry. In addition, even companies involved in this practice generally do not recycle all the waste generated by their production processes.

According to the interviews conducted, we have noticed that the number of companies that establish environmental balance sheets is very small. The absence of this good practice for the majority of companies reveals the existence of a gap in the Tunisian industry. Indeed, the generalization of this exercise provides companies with a better environmental accounting allowing them to optimize their eco-innovative strategies.

The results of this model corroborate those of many previous works empirically proving a positive effect of eco-innovation on firms' environmental performance. To cite a few studies: Larbi-Siaw et al (2022) investigates the impact of eco-innovation on the environmental performance of manufacturing firms in emerging economies case of Ghana.Costantini et al (2017) examine the effect of eco-innovation on the environmental performance of European industries. The same is true, for the work of Long et al. (2017); Li (2014); Cai and Li (2018); Geng et al. (2021) in China; Lee and Min (2015) in Japan; Fernando and Wah (2017) in Malaysia; Tepe Küçükoglu and Ibrahim Pinar (2015) in Turkey; Chiou et al. (2011) in Taiwan.

Table 5

Model 2 results: Effect of eco-innovation on economic performance in terms of growth and profitability

Variables	Coefficients	T-statistics	Significance
Constante	-1.674	-2.128	0.038(n.s)
RCRN	-.021	-0.112	0.91(n.s)
OR	0.264	1.603	0.115(n.s)
UTP	0.256	1.511	0.136(n.s)
RED	-0.142	-0.823	0.414(n.s)
RCMP	0.102	0.639	0.526(n.s)
R-deux	0.120		
R^2ajusté	0.040		
F-statistique	1.502		
Significativité	0.204(n.s)		

(n.s): not significant

From Table 5, we can derive the following multiple regression equation:

Y = - 0.021 (RCRN) + 0.264 (OR) + 0.265 (UTP) -0.142 (RED)+ 0, 102 (RCMP) - 1.674

According to hypothesis (H2), we expect a positive and significant relationship between eco-innovation and firm growth and profitability. Nevertheless, the Fisher F-statistic testing the overall significance of the model takes the value 1.502 with p = 0.204. This indicates that there is no significant relationship between the adoption of eco-innovation and economic performance measured by growth and profitability in the Tunisian context. These results lead to reject this hypothesis.

The observation of the estimated coefficient of the component "reduction of the consumption of natural resources" (RCRN) shows a negative effect on the profitability of the company (-021) and not significant (t = -0.112< 1.96; p=0.911) This indicates that the reduction of fossil energy consumption (by using renewable energy for example) and the minimization of water consumption (via the implementation of wastewater treatment plants internally as an example) is still

[2] World Development Indicators
https://databank.worldbank.org/source/world-development-indicators

expensive in Tunisia. These ecological projects require high investments, which has a negative impact on the company's profitability, especially in the short term.

The component "recycling operations (RO)" shows the following statistical results Coef= 0.264; t= 1.603 with p= 0.115. This would tend to show that recycling operations are not a resort of profitability for Tunisian companies. This phenomenon may be due, firstly, to the recourse of firms to external recycling, which is often costly. Secondly, the investments are high in the case of setting up internal recycling units.

The component "use of clean technologies" (UTP) shows that the use of green technologies is positively related to the profitability and growth of the firm (coef= 0.256). But Student's

T-statistic gives a non-significant relationship (t= 1.511 significantly less than 1.96 with p= 0.136). This result suggests that firms' use of clean technologies is not an explanatory variable for economic performance.

The examination of statistical tests of the waste emission reduction(RED) component highlights that this sub-variable has a negative (coef= -0.142) but not significant (t= -0.823<1.96 with p=0.414) effect on firm profitability and growth. It is concluded that the reduction of pollutant emissions and production waste is a burden for the company and does not affect its profitability.

The component "reduction of raw material consumption" (RCMP) shows that the reduction of raw material use is positively related to the growth and profitability of the firm

(coef= 0.102) while the student statistic gives a non-significant relationship

(t= 0.639<1.96 with p= 0526). This result shows that the firms in Tunisia have not achieved a better profitability through the minimization of raw materials consumed during the production cycle. This phenomenon can be explained by the excessive increase in the selling prices of productive inputs in Tunisia and the depreciation of the Tunisian dinar in case of import of these materials.

Overall, the adoption of eco-innovation by industrial firms in Tunisia does not appear to be a source of improvement in the growth and profitability of firms. This empirical finding can be explained by several factors. First, the introduction of environmental innovations is a relatively recent process in Tunisia. We are facing old industries while their eco-innovative projects are young. This has a double implication: on the one hand, the costs of the first investments in eco-innovation are high, and on the other hand, the return on these investments will require a long period. These arguments converge with the findings made by Cai and Li (2018) and Hojnik and Ruzzier. (2016), who indicate that eco-innovations require high initial investments with long payback times and produce only limited environmental benefits in the short run. Similarly, Dey et al.(2019) show that many firms have primarily viewed eco-innovations as short-term sources of cost.Second, product eco-innovations are generally expensive in Tunisia for various reasons, including the low demand for ecological products, which implies the production of small quantities.This generates high costs and also implies equally high and, therefore, uncompetitive sales prices. Generally, this prevents companies from making financial profits from their ecological innovations. In addition, the import of certain environmentally friendly raw materials that are not available on the local market usually makes eco-innovative products relatively expensive and of a low profitability.

Broadly speaking, previous works testing the effect of eco-innovation on the economic performance have yielded fragmented empirical results. Some observed a positive impact of eco-innovation on firm growth and profitability such as Li (2014); Long et al. (2017); Geng et al. (2021) in China, or Hojnik and Ruzzier (2016) in Slovenia Cheng et al. (2014) in Taiwan. Others did not validate this hypothesis such as Zhang et al.(2012) or Cai and Li (2018) in the Chinese context.

Table 6

Results of Model 3: Effect of eco-innovation on corporate reputation

Variables	Coefficients	T-statistics	Significance
Constante	-1.499	-2.307	0.025**
RCRN	0.466	2.988	0.004***
OR	-0.220	-1.622	$0.111^{(n.s)}$
UTP	-0.225	-1.609	$0.113^{(n.s)}$
RED	0.381	2.678	0.010**
RCMP	-0.025	-0.193	$0.848^{(n.s)}$
R-deux	0.400		
R^2ajusté	0.346		
F-statistique	7.337		
Significativité	0.000***		

*** : significant at the 1% level; ** : significant at the 5% level; * : significant at the 10% level;(n.s)

: not significant

From Table 6, we can derive the following multiple regression equation:

Y = 0.466 (RCRN) -0.220 (GOLD) -0.225 (UTP) +0.381 (RED)-0.025 (RCMP) - 1.499

The multiple regression analysis shows that this model explains the company's reputation. The explanatory power of the model is measured by the adjusted R-two statistic equal to 0.346. The Fisher F-statistic equal to 7.337 and p< 1% allows us to conclude that there is a significant and positive relationship between eco-innovation and corporate reputation.

The empirical findings show that for our sample 40% of the improvement in the company's image is dependent on eco-innovation projects. The examination of the statistical tests of RCRN(coef=0466; t=2.988 and p<1%) and ECO-INN-4 (coef=0.381; t=2.678and p<5%) indicates that the reduction of natural resources consumption such as energy and oil as well as the reduction of polluting emissions and waste are the most explanatory factors for the improvement of the company's reputation in its environment.

However, the OR component "you recycle products, materials etc."; UTP "you use clean technologies" and RCMP "you use clean technologies" show negative and insignificant statistical results.

Given the small size of the Tunisian ecological market and the scarcity of ecological innovations, companies that develop eco-innovations are more likely to obtain competitive advantages over their competitors. This materializes, for example, in the form of a better brand image or improved reputation. This intangible benefit is measured by an improved satisfaction of customers and other parties, accompanied by a higher level of trust. In addition, the adoption of eco-innovations makes the company more respected in its environment, especially by funding and regulatory agencies.

Few previous research studies examined the relationship between eco-innovation and corporate reputation. We note consistency between our results and those of Vidaver-Cohen and Brønn (2015) for Scandinavian countries (Sweden, Denmark, Norway) as well as those of Liao (2018) regarding China.

5. Conclusion

The objective of our study is to examine the impact of eco-innovation on the performance of firms through a survey of Tunisian industrial enterprises. Our results show that eco-innovation has a significant effect on both the environmental performance and the reputation of firms. However, it does not directly improve economic performance in terms of growth and profitability.

One of the main contributions of this study is the exploration of a field of inquiry belonging to developing countries. These countries are marked by the scarcity of empirical evidence on eco-innovation. The second contributionis that we have studied the effect of eco-innovation on firms' reputation while the majority of previous studies focused on environmental and economic performances. The main limitation is that this is a cross-sectional analysis where the sample is observed at a given point in time (time of the interview). In future research, a longitudinal study is recommended, which would allow us to follow the companies over a certain period of time and to observe the evolution of the impact of eco-innovation on the company's performance over time. As a research perspective we propose to analyze the impact of the environmental performance on the economic performance of firms. In addition, we try to adopt the sustainability model called Triple Bottom Line (TBL) proposed by Eklington (1998). This is in the objective to study the impact of eco-innovation on economic, environmental and social performance simultaneously as other researchers have done (Larbi-Siaw, 2022).

Our study revealed the absence of an environmental culture among a large proportion of company managers, which delays the development of eco-innovation. To remove this obstacle it would be advisable to develop training cycles for strategic decision-makers. Also, to develop support systems for environmental projects for all company personnel and to encourage the entry of companies into clusters in order to fill certain gaps in R&D and to strengthen their national and international competitiveness.

The findings of this paper provide important implications for policymakers and company managers. First, it is importantto revise the environmental regulations industry in Tunisia (e.g. electricity production and cogeneration) and to adapt them to the needs of the industry in an international context. Because in interviews with company several of them expressed their dissatisfaction with certain Tunisian environmental regulations. They mention, on the one hand, their rigidity and, on the other hand, their non-conformity with the expectations of the national and international industry. This is therefore in line with the report of the Tunisian Cleaner Production Project[3]conducted in Tunisia. Under the section "adapting the regulatory framework to promote eco-innovation within industries", the experts in charge of this project mentioned the inadequacy of the Tunisian regulatory framework with the specificities of eco-innovation in Tunisia while indicating that "some brakes to the development of industrial symbioses are linked to the Tunisian regulatory framework in force. Citing the example of the decree of 28 September 2010, which sets emission limit values for waste incineration that do not take into account the specificities of which do not take into account the specificities of co-processing, and block its development in Tunisia. In

[3]The TCPP is studying industrial ecology in Tunisia by asking the questions: what are the challenges and solutions for improving the performance of industrial zones and strengthening the economic fabric?
This project is part of the Cleaner Production Programme launched by the United Nations Industrial Development (UNIDO) in cooperation with the Secretary of State for the Economy, Switzerland and the International Centre for Environmental Technology, Tunisia.
http://sofiesonline.com/PPPT/SynthesePP_FR.pdf

addition, the legislation does not allow the exchange of electricity between two companies that do not do not belong to the same group. The development of energy cogeneration is slowed down the development of energy cogeneration is hindered and many companies do not invest in their energy production system. Second, company managers should encourage further training in ecological industry for employees to recognize appropriate opportunities and to better integrate eco-innovation into their process of production.

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