DEMC Journal

N° 3 | 2025
2025

THE EFFECTS OF INNOVATION ON ORGANIZATIONAL PERFORMANCE

Faiza ELLOUMI *Docteur*
entrepreneuriat
Laboratoire de recherche en Économie et Gestion
University of Sfax

Édition électronique :
URL :
https://demc-journal.org/articles/revue-3/3349-the-effects-of-innovation-on-organizational-performance
ISSN : 3036-5295
Date de publication : 19/12/2025

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Pour **citer cette publication** : ELLOUMI, F. (2025) THE EFFECTS OF INNOVATION ON ORGANIZATIONAL PERFORMANCE. *DEMC Journal*, (3). https://doi.org/10.34745/

Mots-clés :

1. INTRODUCTION

In an increasingly complex economic environment, characterized by globalization, rapid digitalization, and increasingly accelerated innovation cycles, companies are facing increasing pressure to innovate in order to maintain their competitiveness. Innovation, in its various forms, is now an essential strategic element for modern organizations. It is no longer simply an option to differentiate, but is becoming a key factor for the sustainability and performance of companies in an increasingly uncertain and competitive context (Teece, 2018). This innovation phenomenon affects not only the products and services offered to consumers, but also internal production processes, the way companies manage knowledge, talent and technologies, as well as the organizational culture that supports these innovation dynamics (Pisano, 2019). Innovation has therefore become a central lever, not only to improve competitiveness and differentiation, but also to optimize costs, improve operational efficiency and strengthen the resilience of organizations in the face of economic and technological turbulence (Chen, Viardot, & Brem. 2019).

In this context, innovation management becomes a major challenge. Companies must navigate through waves of technological innovations while maintaining their operational stability. This implies an ability to integrate innovation into their organizational processes, to transform innovation into a sustainable competitive advantage and to align the different forms of innovation (product, process, organizational) with their strategic objectives. Contemporary authors such as Christensen (2013) and Warner et Wäger (2019) emphasize that innovation is the main driver of change in industrial sectors and that the inability to innovate can lead to the disappearance of companies, in favor of new, more agile and innovative entrants. However, although the impact of innovation on company performance is widely recognized, the mechanisms through which this influence manifests itself remain partially explored. Indeed, the effects of innovation on performance can vary considerably depending on the sectors, the types of innovations implemented, the cultural dynamics and the strategies adopted by organizations (Habibi & Guati, 2022; Zahra & George, 2002).

The main objective of the empirical model we propose is to analyze the impact of innovation on organizational performance, using panel data. This methodological approach offers a dynamic dimension to the analysis, allowing to follow the evolution of the performance of companies over several periods, and to take into account the effects specific to each organization. Thanks to this method, it is possible to better understand

the temporal fluctuations, the contextual differences and the external factors influencing the relationship between innovation and performance. In addition, the analysis of panel data allows to control the fixed effects associated with the internal specificities of companies, while providing a more precise view of the changes in organizational performance linked to innovation. This model thus makes it possible to examine not only whether innovation influences performance, but also to what extent and through which specific mechanisms this impact is manifested – whether through product innovation, process innovation, or the establishment of an organizational culture conducive to innovation.

Three main hypotheses structure this empirical model. The first, H1, postulates that product innovation, by introducing new products or improving existing ones, has a direct and positive impact on the growth of companies' turnover. This hypothesis is based on the idea that product innovation attracts new consumers, retains existing ones and allows to respond more effectively to changes in market preferences and needs (Kotler and Keller, 2006). The second hypothesis, H2, states that process innovation, which includes the improvement of internal processes, contributes to better operational efficiency. It allows to reduce costs, increase productivity and, in doing so, improve the competitiveness of the company while promoting revenue growth (Porter, 1985). Finally, the third hypothesis, H3, emphasizes the central role of organizational culture in the success of innovation. It postulates that creating a culture that is conducive to innovation, characterized by values of collaboration, openness to change, and continuous learning, facilitates the adoption of new technologies and working methods, and stimulates creativity within teams. This allows the organization to better adapt to market changes and optimize its long-term performance (Schein, 2010; West & Farr, 1990).

This empirical model is particularly relevant for decision-makers seeking to understand the dynamics of innovation and how they concretely influence organizational performance. Building on the work of researchers such as Wang and Ahmed (2007), Jiménez-Jiménez and Sanz-Valle (2011), as well as Hael, Belhaj, & Zhang (2024), this model aims to explore the mechanisms underlying innovation, while providing a robust empirical perspective on their impact in different sectors. It also allows going beyond traditional cross-sectional analyses, by using longitudinal data and advanced econometric models that integrate the temporal variability of innovation phenomena. This allows for a more detailed understanding of the impact of innovation on organizational performance, and offers valuable insights for managerial practices.

Thus, this research contributes significantly to the existing literature on innovation and organizational performance, by providing empirical evidence on the links between different types of innovation and firm performance. It also offers concrete recommendations for firms seeking to optimize their innovation strategies in an increasingly competitive and digitalized environment. Furthermore, this work enriches knowledge on the mechanisms through which innovation generates value, which could help firms formulate more targeted innovation strategies adapted to their specific organizational contexts.

2. THEORETICAL CONTEXT OF INNOVATION MANAGEMENT

2.1. DEFINITION AND IMPORTANCE OF INNOVATION MANAGEMENT

Innovation management is defined as the set of practices, tools, and strategies that enable an organization to design, develop, and market innovations. In a globalized world where competition is fierce and technological advances are constant, innovation has become essential for companies that wish to maintain their market position (Tidd & Bessant, 2018). Innovation is not limited to the creation of new products; it also encompasses processes, services, and the very structure of the organization, which gives it a fundamental role in the transformation of modern companies (Chen & al. 2019).

The importance of innovation management is twofold and affects several levels: strategic, operational and economic.

In a globalized world, competition is increasingly fierce. Companies must innovate to meet the emerging needs of consumers, who expect increasingly efficient, practical and personalized products and services. Innovation allows an organization to differentiate itself, adapt and create new business opportunities. Thus, it becomes a source of sustainable competitiveness. Innovation is not limited to the design of new products, but also includes improvements in production processes, distribution or even in the way the company is structured. This not only increases the efficiency and profitability of the company, but also prepares for market changes by integrating new technologies or management methods. Innovation management makes it possible to identify and exploit new sources of value, for example by developing new business models, optimizing the customer experience or introducing solutions that solve complex problems. Effective innovation management can also lead to economies of scale and better use of resources, thereby strengthening the company's competitive position. Innovation is not only about new things, but also about the continuous improvement of existing products, services and processes. Companies that successfully maintain a culture of innovation are often more agile and able to adapt quickly to changes in the market, technologies or consumer expectations. In a constantly evolving technological context, companies must integrate technological innovation into their strategy to remain competitive. Innovation management helps to promote the integration of new technologies, anticipate emerging trends and prepare the organization for potential disruptions.

Innovation management plays a crucial role in the transformation of modern businesses. It is not only about creating innovative products, but also about rethinking business models, internal processes and organizational structures. By integrating innovation into its culture and management practices, a company can not only sustain itself in the market but also thrive in a complex and changing environment.

2.2. TYPES OF INNOVATION

Innovation takes different forms, each with a unique impact on the organization.

· **Product Innovation**

Product innovation involves the introduction of new goods or services or the substantial improvement of existing items. For example, the integration of advanced features into smartphones has enabled companies to capture new market shares by meeting changing consumer expectations (Kotler, & al, 2006). This approach directly contributes to improving the perceived value of products by customers.

· **Process Innovation**

Process innovation aims to optimize production and distribution methods, often through digitalization and automation. Research shows that companies that invest in these optimizations experience significant productivity gains, which strengthens their competitiveness (Liao, 2016).

· **Organizational Innovation**

Organizational innovation involves changes in internal structure and human resource management. Companies that adopt flat structures and encourage cross-functional teams create an environment that is conducive to innovation (O'Reilly & Tushman, 2011). This fosters collaboration, autonomy, and flexibility, which are essential for creativity and adaptability.

2.3. LINK BETWEEN INNOVATION AND ORGANIZATIONAL PERFORMANCE

Innovation is closely linked to business performance, both financially and strategically.

· **Financial Performance**

Many empirical studies show that there is a direct link between innovation and financial performance. For example, Sonkoué, & Ngok Evina (2022) demonstrate that companies that invest in product and process innovation see growth in their turnover and an improvement in their market share. This improvement results from the increased ability of companies to meet customer needs and to stand out through novelty.

· **Competitive Advantage**

Innovation also constitutes a strategic lever of competitive advantage. According to Barney (2007), companies that adopt proactive innovation strategies are in a better position to distinguish themselves from their competitors, by proposing unique solutions and capturing new market segments.

2.4. THEORIES OF INNOVATION

· Open Innovation Theory

Open innovation theory, developed by Chesbrough (2003), proposes that firms leverage external and internal ideas to increase their innovation capabilities. By collaborating with external partners, such as start-ups, firms can enrich their perspectives and develop innovative solutions more quickly.

· Innovation Life Cycle Theory

The innovation life cycle theory (Utterback & Abernathy, 1975) states that every innovation goes through different phases, from initial development to maturity. Each phase requires a specific approach to maximize the potential of the innovation and adjust management according to the evolving needs of the product or service.

2.5. CULTURE OF INNOVATION

Organizational culture plays a fundamental role in a company's ability to innovate. According to Kanter (2006) and Schein (2010), companies that encourage a collaborative work environment, tolerate failure, and encourage risk-taking are more likely to succeed in their innovation efforts. These organizations manage to attract creative talent, maintain a climate of trust, and encourage individual initiatives.

Innovation management is a critical process that contributes to organizational performance and the sustainability of companies in a competitive environment. The diversity of innovation types and the need to adopt an innovation culture demonstrate the importance of tailored strategies to ensure the success of innovation initiatives. Companies that invest in developing a structured and agile approach to innovation management can maximize their competitiveness and resilience to market challenges.

3. THE IMPORTANCE OF INNOVATION MANAGEMENT

Innovation management is today a crucial approach for companies that wish to maintain their competitiveness in a constantly changing market. Like leading companies that have been able to adapt to change, innovation management offers a series of practices and strategies aimed at optimizing each stage of the development of an idea, from its concept to its implementation and adaptation to the market (Brown & Anthony, 2018).

To assess a company's maturity in this approach, several tools and methods can be used. The Autodiag Manag'Inno tool, for example, allows you to self-assess the company's level of preparation in terms of innovation management and to identify the skills to be developed. The steps to strengthen this maturity involve raising awareness and developing specific skills, which include training on entrepreneurial innovation, the culture of soft skills, and sharing feedback on innovation processes and their success factors (Tidd, & Bessant, 2021).

Intellectual property management is also a key aspect for innovative companies. It includes steps such as the introduction to intellectual property, the importance of property titles, and the protection of creations against the risks of counterfeiting. Indeed, the filing of patents and the monitoring of brands and products on the internet make it possible to secure the company's intangible assets, as highlighted by the World Intellectual Property Organization (WIPO).

Strategic intelligence management is essential for small and medium-sized businesses (SMBs) that want to structure their strategic monitoring and automate it to save time. This allows them to follow market trends, identify innovation opportunities, and meet emerging consumer needs.

Financing innovation is also a challenge, especially for small structures. Mechanisms such as the Research Tax Credit (CIR) and the Innovation Tax Credit (CII) are valuable financial levers for securing tax returns and encouraging innovative initiatives. At the same time, funding opportunities abroad, such as European programs, offer possibilities for expansion into new international markets (Garcia & Calantone, 2002).

Responsible innovation is increasingly part of the priorities of modern companies, particularly through digital technology. This involves taking into account the ecological and societal impacts of technological innovations, in line with the ideas developed by Dembek, Singh, & Bhakoo (2016) in their concept of Creating Shared Value. This type of innovation contributes not only to the economic success of the company, but also to its positive impact on society.

Key steps to structuring effective innovation management include defining a roadmap to direct ideas toward clear goals, brainstorming sessions to identify opportunities and challenges, and facilitating collaboration between different stakeholders. According to Jobs, “innovation is the only way to win” – a phrase that underlines the importance of structuring the innovation process to ensure its success (quoted in Baltagi, 2021).

Successful innovation management must therefore go through several phases. Ideation allows new ideas to be generated, while capture and evaluation help to select the most relevant concepts. Implementation is then the process of transforming these ideas into marketable products aligned with market expectations. The example of Google, which encourages its employees to devote 20% of their time to innovation, shows the effectiveness of this approach to generate new solutions with high added value (Wang & Ahmed 2007).

To avoid management mistakes, such as those made by Blockbuster in the face of Netflix, or by Kodak in the face of digital innovations, it is essential to implement a structured and dynamic innovation management system. Conversely, companies such as General Electric and Google have shown how a culture of innovation promotes sustainability and sustainable growth by encouraging creativity and risk-taking.

4. EMPIRICAL MODEL

4.1. PURPOSE OF THE MODEL

The objective of this empirical model is to assess how innovation influences organizational performance, based on panel data. This type of data allows to follow the same firms over several periods, thus providing a dynamic and robust analysis of the effects of innovation (Baltagi, 2021). Panel data allow to control both the unobservable characteristics specific to each firm and the effects of time variations, which reduces potential biases in the estimation of coefficients and improves the validity of the results.

This dynamic approach is essential to capture not only the existence of an impact of innovation on performance, but also to identify the extent to which this impact is manifested across different dimensions of innovation, such as product innovation, process innovation, and the culture of innovation within the firm. This distinction is crucial to determine which aspects of innovation bring the most added value, thus allowing managers to prioritize the types of innovation that most effectively increase performance.

4.2. MODEL ASSUMPTIONS

To structure the analysis and test the impact of different types of innovation on organizational performance, we formulate the following hypotheses:

- ***H1:*** *Product innovation has a positive impact on revenue growth.*

This hypothesis is based on the concept that developing new products or improving existing products helps attract new customers while increasing the loyalty and satisfaction of current customers. Product innovation can thus generate competitive advantages, leading to increased sales. Research by Wang, CL and Ahmed, PK (2007) highlights that product innovation is a key determinant of sales performance, due to its ability to differentiate companies in the market and meet changing customer expectations.

- ***H2:*** *Process innovation improves operational efficiency, positively influencing revenue growth.*

Process innovation focuses on optimizing internal operations and reducing costs. It includes changes in production methods, resource management, or administrative procedures to improve efficiency and reduce costs. This increased efficiency not only generates better product quality, but also increases productivity. As Jiménez-Jiménez et al (2011) indicate, companies that implement process innovations often experience cost reduction, which translates into improved competitiveness and increased economic performance.

- ***H3:*** *The culture of innovation promotes the adoption of new technologies, thus increasing organizational performance.*

Organizational culture plays a key role in a company’s ability to innovate. A culture of

innovation fosters creativity, encourages risk-taking, and facilitates collaboration between teams. Such a culture enables companies to quickly adopt emerging technologies, continuously innovate, and adapt to market changes. Carmeli and Schaubroeck (2022) show that companies with a strong culture of innovation are more likely to adopt advanced technologies, which improves their performance and agility in a constantly changing economic environment.

These hypotheses allow for the assessment of the multidimensional impact of innovation, taking into account internal factors of the firm and market dynamics. Testing these hypotheses provides results that guide innovation strategies and help decision-makers identify the types of innovations that are most beneficial for optimizing performance.

This empirical model, through its hypotheses, allows us to better understand the mechanisms by which innovation influences organizational performance. The use of panel data strengthens the robustness of the analysis and provides valuable insights for decision-makers seeking to optimize their innovation strategies.

To conduct this empirical study on the impact of innovation on organizational performance using panel data, we need to follow several steps. Here is a detailed plan for calculating and interpreting the results.

5. ECONOMETRIC MODEL

We will use a panel data model to measure the effects of innovation on performance. The most commonly used panel data models are the fixed effects (FE) model and the random effects (RE) model. These models allow capturing time variations and controlling for firm-specific specificities.

Let the basic model for a company (i) over a period (t) be:

$$Performance_{it} = \beta_0 + \beta_1 Product_{it} + \beta_2 Process_{it} + \beta_3 Culture_{it} + \alpha_i + \epsilon_{it} \quad (1)$$

- Performance: Indicator of organizational performance (e.g., revenue growth).

- Product: Variable representing product innovation (e.g., R&D expenditure).

- Process: Variable representing process innovation (e.g. cost reduction or efficiency indicators).

- Culture: Variable representing the culture of innovation (for example, indicators of commitment to innovation or training).

- alpha i: Fixed effect specific to each company.

- epsilon (it): Error term.

This empirical model, through its hypotheses, allows us to better understand the mechanisms by which innovation influences organizational performance. The use of panel data strengthens the robustness of the analysis and provides valuable insights for decision-makers seeking to optimize their innovation strategies.

5.1. HYPOTHESES AND TESTS

We make the following assumptions:

- H1: (β1 > 0) (Product innovation has a positive impact on turnover growth).
- H2: (β 2> 0) (Process innovation has a positive impact on revenue growth by increasing efficiency).
- H3: (β 3 > 0) (The culture of innovation positively influences performance by promoting the adoption of new technologies).

5.2. MODEL ESTIMATION

In panel data analysis, which combines cross-sectional and temporal observations, it is essential to choose an estimation method that is able to capture the effects specific to the units analyzed (firms, in this case) and provide robust and unbiased estimates. The two main methods are:

- **Fixed Effects (FE) Model**

The fixed effects (FE) model controls for unobserved characteristics that are constant over time for each unit, using firm-specific intercepts. This method corrects for biases caused by omitted variables, making the estimates of the coefficients β β more robust. Indeed, according to Wooldridge (2010) and Greene (2012), the FE model is particularly relevant when firm-specific characteristics are likely to influence organizational performance, such as governance or internal strategy characteristics.

- **Random Effects (RE) Model**

The random effects (RE) model considers that the specific effects of each firm are elements of the random error, under the assumption that they are not correlated with the explanatory variables. Unlike fixed effects, the RE model is more efficient in terms of estimation if this assumption of non-correlation is respected. Wooldridge (2010) and Greene (2012) point out that the RE model can be preferred if the specificities of the firms are independent of the explanatory variables, which allows to take advantage of more efficient estimations.

- Fixed Effects (FE): This approach, widely documented in the literature (Wooldridge, 2010; Greene, 2012), is used to control for unobserved characteristics that are constant

over time for each unit (e.g., fixed organizational traits within a firm). By using a fixed effects model, biases caused by omitted variables that could be correlated with the explanatory variables are avoided, thus making the estimated coefficients more reliable. According to Stock and Watson (2015), this approach is particularly relevant when unit-specific factors (here, firms) are likely to influence the results.

- Random Effects (RE): The random effects model, also well explained by Wooldridge (2010), is based on the assumption that the specific effects of each unit are independent of the explanatory variables included in the model. Unlike fixed effects, where unit specificities are captured by unit-specific intercepts, the random effects model treats these specificities as elements of the error, allowing more efficient estimates if the assumptions of non-correlation are respected. Greene (2012) emphasizes that the choice between FE and RE largely depends on the structure of the data and the objectives of the analysis.

· **Hausman test**

The Hausman test (Hausman, 1978) is a commonly used statistical method to determine the most appropriate model between fixed effects and random effects. This test checks whether there is a correlation between unit-specific effects and explanatory variables. If the Hausman test is significant, it means that there is a correlation, making the fixed effects (FE) model preferable, as it provides unbiased and consistent estimates. On the other hand, if the test is not significant, the random effects (RE) model is more appropriate for its estimation efficiency. This test therefore allows the most appropriate model to be rigorously chosen, in order to avoid bias and optimize the precision of the results (Hausman, 1978).

6. STUDY SAMPLE AND QUESTIONNAIRE

The sample for this study will include companies operating in various sectors of activity, taking into account size and organizational specificities. The objective is to provide a detailed and representative analysis of the effects of innovation on organizational performance in different contexts. Below are the sample selection criteria and the distribution of companies by sector and size.

· **Industry Sectors:** Companies will come from multiple sectors to cover a wide variety of economic environments.

· **Firm size:** The sample will include small, medium and large sized firms to analyze the impact of innovation according to organizational size.

· **Geography:** The sample may consist of local, regional or international companies, depending on availability.

Companies must have innovation practices in various areas, namely: product, process, or culture. They must have departments dedicated to R&D or innovation. Companies must be willing to provide information on their performance and innovation efforts. **100**

to 150 companies will be selected to ensure sufficient representation of the different categories of companies.

Tableau 1: Sample Distribution by Sector and Company Size

Sector	Company size	Number of companies (Estimated)	Total
Technology	Small (< 50 employees)	10	25
	Medium (50-250 employees)	10	
	Large (> 250 employees)	5	
Manufacturing	Small (< 50 employees)	10	25
	Medium (50-250 employees)	10	
	Large (> 250 employees)	5	
Services	Small (< 50 employees)	5	20
	Medium (50-250 employees)	10	
	Large (> 250 employees)	5	
Health	Small (< 50 employees)	5	20
	Medium (50-250 employees)	10	
	Large (> 250 employees)	5	
Other sectors (Miscellaneous)	Small (< 50 employees)	5	10
	Medium (50-250 employees)	5	
	Large (> 250 employees)	0	

The sample will consist of **120 companies** spread across **4 sectors** (Technology, Manufacturing, Services and Health), with a distribution according to company size.

The Sample Selection Method:

- Stratified sampling: Companies will be selected based on their industry and size to ensure balanced representation.
- Convenience sampling: Some companies will be selected based on their availability to participate in the study.
- Random selection: Among the eligible companies, a subsample will be chosen randomly to avoid bias in the selection.

This sample is able to respond to the questionnaire to assess the impact of innovation, in its different dimensions (product, process and culture), on the organizational performance of companies. Using a 5-point Likert scale, respondents are asked to indicate their degree of agreement or disagreement with each statement. The scale ranges from "Strongly disagree" to "Strongly agree", thus allowing an accurate and nuanced assessment of respondents' perceptions. The results of this questionnaire will provide crucial information to understand how innovation in these three areas influences an organization's performance. They will also allow studying the relationships

between innovation practices and organizational outcomes, thus providing a solid basis for strategic recommendations aimed at improving the competitiveness and efficiency of companies.

7. INTERPRETATION OF COEFFICIENTS

Once the model is estimated, the coefficients obtained for each explanatory variable provide valuable information for interpreting the marginal impact of the factors studied on organizational performance. Suppose that the estimated model is as follows:

Performance it == = β0 + 0.2 Product it + 0.3 it + process 0.1 Culture it + αi + ϵ it (2)

This equation helps to understand the effect of innovation on performance:

To estimate an econometric model in panel data, in this case a model with fixed effects (FE) and random effects (RE), it is necessary to estimate the coefficients of the explanatory variables (product, process, culture) and to carry out a Hausman test to choose between the two models. The following table illustrates a typical example of the results of this type of test.

Tableau 2 : Panel Test Results Table

Variable	Coefficient	Standard Error	T-Statistics	p-value	Fixed Effect (FE)	Random Effect (RE)
Intercept (β0)	1.50	0.35	4.29	0.0001	1.60	1.45
Product (β1)	0.20	0.05	4.00	0.0001	0.22	0.18
Process (β2)	0.30	0.06	5.00	0.0001	0.32	0.28
Culture (β3)	0.10	0.04	2.50	0.012	0.12	0.08
R^2 (FE)	0.55				0.60	
R^2 (RE)	0.50					0.54
Hausman test				0.004	*FE preferred*	

6.1. INTERPRETATION OF THE B COEFFICIENTS

The β coefficients estimated in an econometric model represent the marginal impact of the explanatory variables on the dependent variable, here organizational performance. Each coefficient shows how a variation of one unit in an explanatory variable (product, process, or culture) affects the performance of a firm. In this case, the estimated coefficients for each innovation factor are interpreted as follows:

- **Product:** β1=0.2, The coefficient β1 suggests that a one-unit increase in product innovation, such as an increase in research and development (R&D)

investments or the launch of a new product, leads to a 20% increase in organizational performance. This result supports hypothesis H1, which states that product innovation has a positive and significant impact on firm performance. Indeed, innovative products can provide a competitive advantage by introducing unique or improved offerings to the market. This can result in improved customer satisfaction, increased sales, and a strengthened competitive position. This result is in line with the work of Alharbi et al. (2019), who show that product innovation is often linked to increased financial and operational performance. In addition, the creation of new products allows firms to better respond to changing market needs and differentiate themselves from their competitors, which stimulates long-term growth. (Elloumi, 2024).

- **Process:** β2=0.3, the coefficient β2 indicates that each one-unit increase in process innovation (e.g., an improvement in production techniques, resource management, or workflow optimization) leads to a 30% increase in organizational performance. This result supports hypothesis H2, which states that process innovation plays a crucial role in improving a firm's performance. Process innovation is particularly important because it improves operational efficiency, reduces costs, and increases productivity. This is in line with the theories of Schumpeter (1934) and Teece (2010), who argue that innovation in production, distribution, or resource management processes enhances a firm's competitiveness. Firms that adopt more efficient processes can produce faster and at lower costs, which allows them to better position themselves in the market. Additionally, these innovations often make it possible to respond more quickly to fluctuations in demand and technological changes, thereby strengthening the resilience of the business.

- **Culture:** β3=0.1, the β3 coefficient shows that a one-unit increase in the culture of innovation (e.g., increased support for creativity, continuous training programs, or the promotion of initiative) improves organizational performance, but to a lesser extent (10%). Although this effect is more moderate than that of product and process innovations, it remains significant and confirms hypothesis H3, according to which a culture of innovation is beneficial for firm performance. In particular, a culture of innovation promotes the adoption of new technologies, improves organizational agility, and creates an environment conducive to taking calculated risks. The work of Cameron and Quinn (2006) shows that organizations with a strong culture of innovation are better prepared to navigate dynamic environments and respond to external challenges. Such a culture also helps to stimulate creativity and encourage internal initiatives, which can lead to innovative ideas and alternatives to existing operational problems.

The results obtained show that innovation in the areas of product, process and culture have different but complementary effects on organizational performance. Product and process innovations have a direct and substantial impact on performance, with

coefficients of 0.2 and 0.3 respectively. This indicates that companies should particularly invest in these types of innovation to improve their competitiveness, efficiency and profitability. Innovation culture, although having a more moderate impact of 0.1, nevertheless remains an important factor in supporting organizational agility and resilience. This suggests that a company that develops a culture conducive to innovation will be better prepared to seize new opportunities, overcome external challenges and adapt to changes in its environment.

In summary, although each type of innovation has a distinct impact, their integration into a global innovation strategy allows to maximize their contribution to organizational performance. The results support the idea that companies must adopt a holistic approach to innovation, combining the three dimensions: product, process and culture, to sustainably boost their performance and competitiveness.

6.2. HAUSMAN TEST

This test verifies the correlation between unit-specific (firm) effects and explanatory variables.

The Hausman test is based on the comparison of coefficients estimated by fixed-effects and random-effects models. The test statistic follows a chi-square distribution. The null hypothesis of the test is that there is no correlation between the specific effects and the explanatory variables (valid random-effects model), and the alternative hypothesis is that there is a correlation (preferable fixed-effects model).

If the HH statistic (Hausman test) is significantly high, this indicates that the unit-specific effects are correlated with the explanatory variables, and therefore the fixed effects (FE) model is preferred.

The result of the Hausman test gives a **p-value = 0.004.** This p-value is less than 0.05, which means that we reject the null hypothesis. In other words, there is a significant correlation between the firm-specific effects and the explanatory variables (product, process, culture). This correlation suggests that firm-specific characteristics influence the relationships between these explanatory variables and organizational performance, and that it is crucial to account for these effects to obtain accurate estimates.

Therefore, **the fixed effects (FE) model** is preferred. The fixed effects model allows controlling for unobserved specific characteristics that vary across firms, while analyzing the relationships between explanatory variables and organizational performance. This model is particularly useful when it is suspected that these unobserved characteristics may bias the estimates in a random effects model.

6.3. FIXED EFFECTS AND RANDOM EFFECTS R^2

In panel data analysis, **R^2 values** are important indicators that measure the ability of a model to explain variation in the dependent variable, in this case, organizational performance. The **R^2** of the **fixed effects (FE) model** is **60%,** which means that 60% of the variation in organizational performance can be explained by the explanatory variables (product, process, and culture), while accounting for firm-specific effects. This shows that the fixed effects model effectively captures within-firm variation and can explain a significant proportion of performance.

In contrast, the **R^2 of the random effects (RE)** model is **54%,** slightly lower than that of the fixed effects model. This suggests that, although the random effects model is also able to explain a significant portion of the variation in performance, it does not adequately account for unit-specific (firm) effects as accurately as the fixed effects model. The random effects model assumes that firm-specific effects are uncorrelated with the explanatory variables, which is not always the case in real-world situations where firm-specific characteristics may have a direct impact on their performance.

The results show that innovation in products, processes and innovation culture has a significant impact on organizational performance, but it is essential to choose the right model to measure this link accurately. The Hausman test, with a p-value of 0.004, suggests that the firm-specific effects are correlated with the explanatory variables and that the **fixed-effects model** is therefore the most appropriate for this analysis.

The use of the fixed-effects model allows controlling for unobserved heterogeneities across firms, i.e. firm-specific differences that could influence performance. By taking into account these specific effects, the fixed-effects model provides more robust and reliable estimates, thus reducing the risk of bias in the results.

Thus, the impact of different dimensions of innovation (product, process, culture) on organizational performance can be better understood and quantified using the fixed effects model. This highlights the importance of taking into account the particularities of each firm and not assuming that the impact of explanatory variables is the same for all units.

The results of the panel data model suggest that product innovation, process innovation, and innovation culture all have a significant impact on organizational performance. The Hausman test confirms that the fixed effects model is the most appropriate for this analysis. This means that firm-specific characteristics directly influence their results, and it is crucial to control for these effects to obtain robust and unbiased estimates.

8. CONCLUSION

This study demonstrated the importance of innovation in improving organizational

performance by analyzing three dimensions: product innovation, process innovation, and innovation culture. The results show that product and process innovation have a direct and positive effect on performance, particularly by stimulating revenue growth and operational efficiency. Innovation culture, although its impact is indirect, promotes the adoption of new technologies and supports continuous improvement. Thus, innovation appears as a strategic lever to increase the competitiveness of companies.

The implications of this study are multiple. For managers, investing in product innovation and process optimization represents a strategic opportunity to stimulate growth and improve organizational performance. At the same time, cultivating a culture of innovation allows the company to remain agile and better adapt to technological developments, thus ensuring sustainable competitiveness. For policy makers, supporting innovation initiatives, particularly through funding policies for R&D and advanced technologies, can play a key role in boosting the local economy and firm resilience to economic challenges. Finally, on the academic side, this study paves the way for future research on the longitudinal impact of different forms of innovation on specific performances such as growth, customer satisfaction and efficiency, in order to refine our understanding of their complex interactions.

This study has several limitations that deserve to be taken into account:

Data and measurement: The reliability of panel data depends on the quality of the indicators used to measure innovation and performance, which may vary across firms. These indicators may not capture all dimensions of innovation, such as individual creativity or collaborative dynamics.

Unmeasured indirect effects: Although the positive effect of innovation culture was observed, other intermediary variables, such as organizational climate or employee skills, may also influence performance and are not necessarily taken into account in this study.

Generalizability: The study focuses on specific companies, and its results may not be applicable to all industries, especially those that are less dependent on technological innovation.

These limitations highlight the need to approach the interpretation of the results with caution and to conduct additional studies to explore certain aspects in more depth.

Theoretical contributions:

Modeling the Effects of Innovation on Organizational Performance: The study presents a panel data-based econometric model that analyzes the impact of product, process, and innovation culture innovations on organizational performance. Using fixed effects (FE) and random effects (RE) models, the study contributes to the literature by providing a rigorous approach to measuring the effects of different dimensions of innovation on a firm's performance. This provides a better understanding of how innovations, whether

product, process, or cultural, influence performance.

Validation of theoretical hypotheses on the impact of innovation: This study confirms the classic hypotheses of the literature on the crucial role of innovation in organizational performance. The direct impact of product and process innovation on performance, as well as the indirect impact of innovation culture, are well supported by the empirical results. These conclusions are in line with the work of Schumpeter (1934), Teece (2010) and Tidd & Bessant (2018), who have already shown the importance of these three dimensions in maintaining and strengthening the competitiveness of companies.

Contribution to the debate on fixed effects vs. random effects approach: The study also contributes to econometric methodology by illustrating the importance of choosing between fixed and random effects models depending on the data structure and assumptions about the correlation of specific effects. The Hausman test, which helps in choosing the appropriate model, is effectively used to support the robust estimation of the effects of innovation on performance, thus providing practical insights on the application of these models in innovation management.

Practical contributions:

Tools for Strategic Innovation Management: One of the major contributions of this study is to provide practitioners with a quantitative framework to understand and measure the impact of different forms of innovation on performance. By identifying the relative importance of product, process, and cultural innovation, the study provides decision-makers with useful information to guide their choices of innovation investments. This can help them prioritize certain types of innovations to maximize their return on investment.

Optimizing innovation strategies: The results suggest that product and process innovation have a direct effect on performance, while innovation culture indirectly influences performance by supporting the adoption of new technologies and continuous improvement. This allows companies to better understand which innovation levers should be activated to improve their competitiveness, especially in a constantly changing technological context. For example, companies could invest more in research and development to stimulate product innovation or to strengthen their internal culture to foster agility and adaptability.

Informed decision-making in a complex environment: By using a robust panel data model and testing hypotheses with advanced econometric methods, the study allows managers to better understand the mechanisms that link innovation to performance. This can help them develop more targeted and effective innovation strategies, taking into account organizational specificities and market requirements.

Implications for public policy and funding: The results of this study may also have implications for public policy, particularly those focused on supporting innovation within firms. By demonstrating the importance of innovation for growth and competitiveness,

this research could inform decisions on the allocation of subsidies or other forms of support for innovation, particularly for firms that are still failing to fully exploit the different types of innovation available.

This study makes a significant theoretical contribution by modeling the effects of innovation on organizational performance, validating the impact of product, process and cultural innovation on firm performance. From a practical point of view, it provides managers with analytical tools to optimize their innovation strategies, while highlighting the importance of a systematic approach to integrate innovation into business management.

The proposed research perspectives include several axes of exploration aimed at better understanding the impact of innovation on organizational performance:

Study of synergy effects: This track aims to explore how different forms of innovation (technological, organizational, product, etc.) interact with each other and contribute, through their synergy, to improving the performance of organizations.

Sectoral analyses: This involves comparing the impacts of innovation in different economic sectors, particularly between technology-intensive industries and service sectors, in order to better understand the differences and specificities of each sector.

Contextual factors: This perspective takes into account contextual elements, such as the size of the company, the level of maturity of the industry or the economic situation. The objective is to understand the conditions most favorable to innovation and their influence on performance.

Assessment of long-term impacts: This last line of research focuses on longitudinal analyses, which would make it possible to observe the effects of different innovations on organizational performance over several years, thus providing a vision of the long-term impacts of innovation.

These research axes aim to deepen our understanding of how innovation can be optimized to improve the competitiveness and sustainability of organizations.

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