Research Article

Received: 20 March 2024 / Accepted: 19 June 2024 / Published: 02 July 2024

Evaluation of Innovation Capacity and its Impact on Sales in Ecuador's Manufacturing Sector: An Econometric Analysis

Tania Morales[1]

Nicolay Salazar[2]

Anderson Argothy[2]*

[1]*University Indoamerica,*
Ambato,
Ecuador
[2]*University Technical of Ambato,*
Ambato, Tungurahua,
Ecuador
**Corresponding Author*

DOI: https://doi.org/10.36941/ajis-2024-0097

Abstract

The primary aim of this study is to evaluate the capacity for innovation and its impact on sales in manufacturing companies in Ecuador. This study used data from the Survey of Science, Technology, and Innovation Activities in Ecuador. Correlation and multiple linear regression analyses were also performed. These results align with economic theories and indicate a positive association between certain innovation and sales indicators. Insufficient R&D investment negatively affects the innovation status of companies of various sizes in Ecuador. This study suggests that businesses ought to foster a culture of innovation, facilitate collaboration and strategic partnerships, and increase their financial resources for innovation and sales to achieve growth, survival, and sustainability in the current market.

Keywords: *Innovation Capacity; Sales; Competitiveness; Economic growth; Economic Development*

1. Introduction

Innovation is basic for any country's progress (Sun et al., 2023), and an organization's capacity is defined as its ability to execute productive activities in an efficient and effective way through the combination and coordination of resources and competences through several value-creating processes,

The inventive entrepreneur converts ideas into inventions, which into products with commercial or industrial applications and is closely related to innovation (Schumpeter, 1947). On the other hand, innovation is also defined as the practical implementation of new ideas in a new process (OECD, 2005, 2018)

Regional innovation systems are a key part of competitiveness, providing facilities that can

impact organizations in the development and acquisition of capabilities (Alatrista, 2022; Cooke et al., 1997). They are also seen as a way of analyzing the different elements that characterize a region in terms of their capacity to develop innovation processes.

Within regional innovation systems there is a focus on Innovation Capacity (IC). Pérez et al. (2015), state that IC refers to the company's ability to generate and transform ideas and knowledge. There are three main perspectives: i) Functionalist: This is responsible for analyzing the IC that should be developed by the different functional areas. ii) Processes: To understand these in terms of the stages of the innovation process, from idea generation to product commercialization. iii) Assets: This conceives of the relationship between the types of innovation, products, and processes (Camisón & Villar-López, 2014).

The Oslo Manual states that a firm's general capabilities and innovation capabilities are related, and these two sets of assets are used to develop innovation strategies (OECD, 2005, 2018). Innovation capabilities are closely related to sales growth and competitive advantages.

Porter (1990) mentions that innovation capacity and knowledge are key factors in business competitiveness. This is based on the interaction between infrastructure and the built environment, accessible natural resources, institutional endowments, and knowledge and skills. Localized capabilities are developed in the territory, which are difficult to imitate and cumulative in nature, leading to competitive advantages (Archibugi & Coco, 2004).

Organizations that employ a highly competitive dynamic aim for innovation are systematic, managed, measured, and controlled. Thus, it is necessary to develop and strengthen the skills and capabilities that enable innovation.

The lack of high-level studies and research supporting the importance of strengthening innovation capacity is evident (Robayo, 2016) and the definition of an innovation profile has not been clearly established. Therefore, in accordance with the innovation principle, mechanisms are sought to ensure more effective regulations, improved governance, and greater incentives (Boon & Edler, 2018)

Innovation capability is a crucial element in contemporary entrepreneurship, as its primary focus is on business transformation (Watkins et al., 2015). For entrepreneurs, fundamental activities such as feasibility studies, selection of technology and suppliers, and scheduling of activities are indispensable, as they constitute essential components of daily large-scale production.

In Tehran Province, fishing companies claim that the development of innovation capacity is critical to achieving innovation returns and productive outcomes (Dehyouri et al., 2024). This argument holds true during the Covid-19 crisis. Innovation plays a key role in generating value and preserving sustainable and competitive advantage.

On the other hand, in China, manufacturing companies that achieve a competitive advantage in the sector base their success in technological innovation (Hu & Jefferson, 2004), as scientific and technological innovation emerges as a new driver of economic growth. In this context, the leap towards high-quality and sustainable economic development cannot be delayed, given the transformation in the economic development paradigm (Liu & Yang, 2023).

According to Smith (1776), the development of machinery and tools and the desire of workers to improve themselves leads to an increase in production capacity. Therefore, the innovation process runs sequentially, starting with idea generation, construction, engineering or research units, implementation, and diffusion or introduction to the market (Saari et al., 2015)

Economic theory shows a positive relationship between R&D spending and the incomes of public and private companies (Crespi et al., 2016; Schot & Steinmueller, 2018). The relationship shown in the literature supports the use of the sales and R&D expenditure variables in this study.

On the other hand, according to the WIPO (2022), Ecuador performs better in terms of inputs than innovation outcomes. Ecuador ranked 96th in inputs, down from the previous year, but the same as in 2020. In terms of outcomes, in the Global Innovation Index, Ecuador ranks 98th, which is lower than that in 2021 and 2020.

Ecuador has been an agricultural exporting nation that prioritizes free trade policies, giving preference to middle-class and small-scale producers. (Terán & Guerrero, 2020). However, the agricultural sector generates 9.28% of the total domestic product. (Asobanca, 2022), without giving it

any weight to the industrial sector in general or the metalworking sector in particular, which contributes significantly to the national economy. According to data from the National Accounts Annual of the BCE, the contribution of the mechanical industry is 24.09 percent of the total industrial sector. (Banco Central del Ecuador, 2022), The metalworking industry is significant and should be researched using several lenses.

Therefore, it is important to emphasize that this study is to evaluate the capacity for innovation and its impact on sales in manufacturing companies in Ecuador. In this way, it seeks to influence the productive sectors, encouraging them to invest more in the capacity of business innovation, with the purpose of increasing their level of competitiveness in the market, consequently increasing the average annual sales of companies.

This paper is organized into five sections, beginning with the introductory section. Section 2 provides a comprehensive review and discussion of the literature on innovation capacity in the manufacturing sector. In Section 3, we offer a detailed explanation of the methodology to be employed. The results of our analysis are presented in Section 4, with in- and out-of-sample analysis using real data in Section 5, where we succinctly summarize the key findings.

2. Literature Review

Innovation is defined as a process focused on the creation of new products through the implementation of new processes, the reorganization of the organizational structure, and the exploration of new markets (Schumpeter, 1934, 1947). Knowledge-based innovations are distinguished from other innovations by the time required, failure rate, and predictive capacity. Innovation must be simple and focused upon. Introducing an innovation in the market is usually accompanied, in most cases, by new inventions aimed at improving or complementing the initial innovation, whether it is a product or a service (Drucker, 2004).

According to the Oslo Manual (2005), innovation focuses on enhancing a company's competitive advantage by creating new products, improving the quality of existing products, and expanding into new markets. This approach implies the improvement of innovative skills, which translates into an increase in a company's capacity to develop new processes and products.

Innovation is achieved through the strategic location of innovation centers and R&D laboratories, allowing the dissemination of technical knowledge (Archibugi & Pietrobelli, 2003). Countries make efforts to measure innovation using variables such as patents, which act as an indicator of the result, and R&D expenditures as a measure of the level of effort involved (Carrasco-Carvajal et al., 2023; Corrente et al., 2021). However, innovation is not only defined as the application of R&D results at a high level; it is also the result of strategic, entrepreneurial, organizational, and decision-making capabilities.

Developed and developing countries aspire to establish Innovation Systems and models that allow them to effectively compete in the market for goods and services. Each country makes efforts to develop innovation, and its strategies differ, as shown in Table 1.

Table 1: Innovation characteristics of developed countries.

Countries	Features
Europeans	Variable labor costs
Netherlands	Existence of strong ties between the private sector and academia.
Germany	Scientific specialization in fields such as physics, chemistry and mathematics.
France	High level of technology used in chemicals and equipment.
Italy	
Anglophones	
Australia	Flexibility of the labor force in terms of supply in the labor market.
Canada	High industrial specialization.
United States	Aerospace and pharmaceutical industry focused on technology and innovation.
Great Britain	

Countries	Features
Scandinavians **Finland** **Sweden** **Norway**	Internationalization of research. Expansion of research internationally. High levels of spending on education. Implantation of technological specialization in the management of resource-intensive industries.
Japan	Electronics, capital goods and consumer electronics are the focus of intense sector specialization. Flexible labor management Concentration on Research and Development for Industrial Production Management

Source: (Amable et al., 2008; Ekboir & Parellada, 1999; Furman et al., 2002)

The manufacturing industry is one of the sectors that demand innovation. In this sector, innovation is at the core of entrepreneurship; every new company in the market is born from innovative performance compared to its competitors in the market (Sánchez, 2011). To maintain competitiveness, organizations must be aware of the strategic value of innovation and integrate methods and tools that allow them to manage it effectively (Hidalgo 2011). The vast majority of new knowledge is born from problem solving and often arises through trial and error.

3. Innovation Capacity

The development of innovation capability has emerged as an intricate process, particularly challenging for developing countries, given the inherent complexity of its determinants. Through a literature review, the key determinants of innovation were identified, some of which were also considered to be Innovation Capacity.

At the regional level, research focused on measuring innovation capacity in manufacturing companies had as its objective the design of a system for measuring technological ICs in products and processes, with the purpose of applying it to the manufacturing industry in the State of Carabobo, Guacara Industrial Zone (Ortiz et al., 2007). The variables considered were innovation, commercialization, design, certification, research and development (R&D), technology incorporated into capital, technology not incorporated into capital, and product and process innovation.

The national innovation capacity depends on a strong common innovation infrastructure, the innovation environment of industrial clusters, and the strength of the linkages between the two (Edquist, 2019)

Table 2 summarizes the methods used to study innovation capacity.

Table 2: Literature review of the determinants of innovation capability.

Author	Description
Opening (Beaudry & Kananian, 2013).	Impact of international trade, e.g. ICT imports and high-tech exports, Foreign Direct Investment (FDI), and venture capital.
Investment in fixed capital (Liu & Yang, 2023)	Investment in infrastructure and investment in renovation and refurbishment.
Private R&D expenditure (Barona-Zuluaga et al., 2015; Beaudry & Kananian, 2013; Forsman, 2011; Furman et al., 2002; Salazar-Elena et al., 2016; Yam et al., 2011).	R&D expenditures financed and carried out by industry and companies.
R&D performed by universities (Acosta et al., 2020; Barona-Zuluaga et al., 2015; Beaudry & Kananian, 2013; Furman et al., 2002).	Expenditures made and financed in R&D activities by universities.
Gross R&D expenditure (Acosta et al., 2020; Furman et al., 2002; Nathai-Balkissoon et al., 2017; Yam et al., 2011).	Current expenditures on R&D work, which are systematically carried out for the continuous advancement of knowledge and its new applications.
R&D manpower (Liu & Yang, 2023; Mendoza-Silva, 2021).	It is equivalent to full-time equivalents (FTE) or working hours.

Author	Description
R&D personnel on a full-time basis (Ciriaci, 2017; Furman et al., 2002; Nathai-Balkissoon et al., 2017).	Engineers, scientists and full-time R&D professionals, focused on the creation and conception of new knowledge, improve and investigate models, theories, software, methodologies and instrumentation or operational techniques in all sectors.
Spending on new products; % of sales of new products; Machinery and external expertise; Training (Mendoza-Silva, 2021).	Spending on new products. Total percentage of sales of new products. Expenditures focused on machinery and external knowledge. Educational level and training, certifications and accreditations o Resources allocated to training.
Importance of the university/research institution (Forsman, 2011; Furman et al., 2002).	Promotion and position of public and private research institutes.
Promotion and protection of innovation and intellectual property (Furman et al., 2002; Mendoza-Silva, 2021; N. Smith & Thomas, 2017).	Extent to which a country promotes and protects intellectual property (IP).
Utility models (N. Smith & Thomas, 2017).	Form of intellectual property protection.
Co-inventions (Ketonen-Oksi, 2018).	Patent family applications with co-creators located abroad.
Patent applications (Mendoza-Silva, 2021).	Number and type of patent applications filed.
Number of patents (Lordén & Morelo, 2020).	Total number of patents of the company or entity.
Trademark application (Lee, 2012).	Creation of a sign to distinguish b/s by owners of particular goods or providers of particular services.
Licenses granted (Mendoza-Silva, 2021).	Number of licenses granted.
No. of conceptualization projects initiated (Mendoza-Silva, 2021).	Number of projects considered as an idea, attitude, or even a progress of actions aimed at achieving a certain end.
Revenues (Mendoza-Silva, 2021).	Total company income.
Multi-stakeholder R&D collaboration (Adikari et al., 2021; Furman et al., 2002).	Extent to which universities and companies carry out collaborative R&D activities.
Cluster development status (Forsman, 2011; Lewis et al., 2018).	Degree of extension of the innovation clusters.
Overall labor productivity (Mendoza-Silva, 2021).	Labor productivity or productivity per hour worked.

Source: (Mendoza-Silva, 2021; Novillo-Villegas et al., 2022).

Given their intangible nature, indirect measures, either objective or subjective, have traditionally been used in the field of innovation capacity assessment. In this context, objective measures focus on the input perspective, identifies the innovation process related to investment in training and the number of people dedicated to research and development (R&D) (Awad et al., 2020).
Regarding contributions to the study of innovation capability, Ngo and O'Cass (2012) argue that IC involves activities related to the market, goods and services, production processes, management, and marketing. Hogan et al. (2011) proposed a scale that encompasses three specific dimensions in the context of professional services: i) client-centered innovation capability, which seeks to offer unique and innovative solutions focused on solving client problems; ii) market orientation, which introduces events that promote the company and adopts revolutionary forms of marketing for the industry; and iii) technology-focused, which introduces new systems and applied technologies (García et al., 2018; García et al., 2014).

Hong et al. (2015) suggest the creation of a quantitative index that evaluates both input (R&D expenditure) and output, represented by sales and revenue.
By contrast, IC encompasses intrapreneurship, technological leadership, strategic renewal, innovation portfolio management, value chain leverage, and proactive adaptability (Ashal et al., 2023). Similarly, designed a scale that encompasses four dimensions: technology, innovation, product development, and strategic capabilities (Hanaysha et al., 2022). However, a specific measurement of innovation capability aimed at SMEs that considers five criteria: organizational aspects, employees, infrastructure, external factors, and the role of the manager/CEO (Donbesuur et al., 2020; Hanaysha et al., 2022).

4. Materials and Methods

This research used information from the survey of Science, Technology, and Innovation Activities of Ecuador (ACTI) for the period 2012-2014, the latest information available on innovation in the country. The data was collected by the National Institute of Statistics and Census of Ecuador (INEC) and the National Secretariat of Higher Education, Science and Technology of Ecuador (SENESCYT), a national survey conducted by official agencies. The database is of 6250 companies, and a sample of 150 companies in the metal industry, located in the province of Tungurahua, was selected. This province is an important part of the development of Ecuador's industry. Correlation analysis was performed using Spearman's rho, with the data cleaned and treated using statistical techniques. The variables with the highest correlation with the dependent variable were included in a multiple linear regression model using the ordinary least squares (OLS) method to measure the effect of the independent variables on the dependent variable using the Rstudio software.

The variables selected based on the literature review and availability of information in the survey were as follows.

4.1 Dependent variable

Annual sales: Total revenue of the business from product sales before deductions.

Independent variables:

a) Investment in fixed capital: Disbursement of financial resources by a company or organization to acquire physical assets.
b) Internal R&D expenditure: Expenditure on R&D activities carried out within the research center or unit.
c) External R&D expenditure: Expenditure for R&D activities carried out outside the research center or unit.
d) Expenditure on the acquisition of machinery and equipment: expenditure incurred for acquiring machinery and equipment.
e) Expenditure on hardware acquisition: Expenditure incurred for acquiring hardware.
f) Expenditure on software acquisition: Expenditure incurred for acquiring software.
g) Expenditure on hiring consulting and technical assistance: This expenditure focused on hiring consulting and technical assistance.
h) Expenditure on personnel training: expenditure incurred for the purpose of training personnel.
i) Expenditure on engineering and industrial design activities: Expenditure incurred in engineering and industrial design activities.
j) Expenditure on market research: Expenditure incurred in market research.

Las variables fueron fueron analizadas para eliminar datos atípicos y el correcto tratamiento de datos perdidos.

Correlation analysis was performed to identify the association of the variables, their strength and relationship with the literature reviewed. This was done as a previous step to the econometric estimation.

A multivariate econometric model estimated by the ordinary least squares method was used, due to the type of data. In addition, the respective validations of the model were carried out.

The OLS model equation to be estimated is:

$$Y_i = \beta_0 + \beta_1 ICF + \beta_2 GAME + \beta_3 GAH + \beta_4 GAS + \beta_5 GIDI + e \quad [1]$$

Yi = Sales

βo = Intercept

βk = Regression Coefficients

ICF = Investment in fixed capital

GAME = Expenditure on Acquisition of Machinery and Equipment

GAH = Hardware Acquisition Expense
GAS = Expenditure on acquisition of software
GIDI = Expenditure on internal R&D
e = error
The results of the methodological application are presented below.

5. Results and Discussion

This section presents the main results derived from the methodological applications. This study analyzes the effect of Innovation Capacity and its relationship with sales in metal industry companies in Ecuador.

Table 3 presents the results of the correlation analysis.

Table 3. Spearman's Rho

Variables	1	2	3	4	5	6	7	8	9	10
1. Sales	1,000									
2. Investment in fixed capital	,374**	1,000								
3. Internal R&D	,114*	,215**	1,000							
4. External R&D	0,039	,100*	,159**	1,000						
5. Machinery and equipment	,155**	,526**	,275**	,239**	1,000					
6. Hardware	0,086	,302**	,239**	,093*	,352**	1,000				
7. Software	,115*	,312**	,204**	0,068	,230**	,512**	1,000			
8. Consulting and tech assistance	,191**	,342**	,373**	,299**	,314**	,385**	,281**	1,000		
9. Industrial Engineering Design	0,034	,173**	,379**	-0,013	,190**	,165**	,159**	,237**	1,000	
10. Training	,183**	,271**	,290**	,198**	,326**	,286**	,230**	,490**	,346**	1,000
11. Market research	-0,018	0,062	,365**	0,083	,155**	0,080	,164**	,105*	,252**	,260**

* Correlation is significant at the 0.05 level.
**Correlation is significant at the 0.01 level.

The application of Spearman's rho simplified the identification of variables with a stronger connection to the dependent variable (sales) and determinants of Innovation Capacity (IC). In this case, investments in fixed capital, internal R&D, machinery and equipment, software purchases, and expenditures on consulting and training show a correlation with the sales variable. The remaining innovation capabilities did not show a significant relationship. The estimation results for the model parameters are as follows:

A variable selection method called backward stepwise regression was applied, where the predictor variables were introduced, proceeding to exclude them one after the other according to the individual t-test or F-test, which justifies the elimination of the less influential and less significant variables. Expenditure on external R&D, personnel training, engineering and industrial design activities, contracting and technical consultancy, and market research.

Table 4. Estimated model.

Código	Variables	Estimate	Std. Error	t value	Pr(>|t|)	
	(Intercept)	-1,43E+07	5,55E+08	-0.026	0.9795	
ICF	Investment in fixed capital	6,01E+03	9,44E+02	6.371	4.70e-10	***
GAME	Machinery and equipment	4,51E+03	2,49E+03	1.815	0.0702	.
GAH	Hardware	5,57E+05	1,22E+05	4.556	6.75e-06	***
GAS	Software	1,40E+05	3,46E+04	4.037	6.39e-05	***
GIDI	Internal R&D	4,21E+04	1,97E+04	2.143	0.0327	*
	Residual standard error	11770000 on 440 degrees of freedom				

Código	Variables	Estimate	Std. Error	t value	Pr(>|t|)	
	Multiple R-squared	0.359	Adjusted R-squared		0.3518	
	F-statistic	49.63	p-value		2.2e-16	

The coefficients 6.01E+03 (ICF), 4.51E+03 (GAME), 5.57E+05 (GAH), 1.40E+05 (GAS), and 4.21E+04 (GIDI) correspond to regression coefficients β_1, β_2, β_3, β_4, and β_5 in the model. These values indicate the change in sales in response to a unit change in each independent variable (ICF, GAME, GAH, GAS, and GIDI).

Therefore, the coefficient of Investment in Fixed Capital (ICF) is statistically significant. A one-unit increase in fixed capital investment is associated with an estimated increase in the dependent variable, holding all the other variables constant. The consistency of this approach is supported by theoretical approaches, indicating that, as companies strengthen their innovation capacity (IC), an improvement in both financial and non-financial performance is observed. The latter includes aspects linked to brand value, customer satisfaction, and processes for adding value to goods and services (García etal., 2018; García et al., 2014).

GAME (Expenditures on Machinery and Equipment Acquisition) is not significant at the 5% confidence level.

Hardware acquisition expenditure (GAH) is significant, indicating that a one-unit increase in hardware acquisition expenditure is associated with an increase in the dependent variable. This finding is in line with theoretical approaches that argue that innovative firms should cultivate management skills in relation to both tangible and intangible assets (Morales et al., 2016).

Software Acquisition Spending (GAS) indicates a significant positive relationship between software acquisition expenditure and the dependent variable; that is, a one-unit increase in software acquisition expenditure is associated with an increase in the dependent variable. In this context, Ngo and O'Cass (2012) suggest that it is a factor in the marketing, production, and management of companies.

The Internal R&D expenditure (GIDI) coefficient is significant and a one-unit increase in internal R&D expenditures is associated with an increase in the dependent variable. This finding suggests that internal R&D expenditures are positively related to the dependent variable. It is important to highlight that, like research focused on Innovation Capacity (IC) measurement systems in manufacturing firms, the inclusion of the internal R&D expenditure variable is justified in the analysis of the innovation capacity of manufacturing firms in the Tungurahua province (Ortiz et al., 2007).

The coefficients of ICF, GAME, GAH, GAS, and GIDI were statistically significant. Additionally, the F-statistic and its p-value indicate that the model as a whole is statistically significant, with a coefficient of determination (R-squared) of 0.359, which means that the model explains 35.9% of the variability in the dependent variable. The results of the multicollinearity tests (VIF) of the model variables showed (1.8) an average of 1.8, indicating no multicollinearity.

6. Conclusions

This study evaluated the capacity for innovation and its impact on sales in manufacturing companies in Ecuador.

Consequently, a descriptive analysis of some of the determinants of innovation capacity was conducted based on a literature review. Owing to the relatively low level of development of companies, the introduction of advanced technological projects in the industry, investment in R&D, and different preferential policies have a greater potential for development (Shen & Lin, 2020).

There are several innovation indicators; in this case, those that data availability allowed were selected. These made it possible to identify the capacity for innovation and its effect on sales in the case of Ecuador.

Analyzing the innovation capacity of manufacturing companies involves evaluating their ability

to implement, generate, and maintain new products and processes that allow them to adapt to the changes generated in the market, considering all existing knowledge in the organization (Nonaka & Takeuchi, 1995). In general, companies should strengthen the factors that denote a greater intensity of association with sales. Therefore, resources should be prioritized for investment in fixed capital, personnel training, hiring consultants and technical assistance, internal R&D, software acquisition, and machinery and equipment acquisition (Zastempowski & Cyfert, 2022)

Promoting these capabilities in organizations helps develop innovation and improve sales; however, it is not a guarantee that the company will develop innovative products or services. On the contrary, not developing these capabilities within the company guarantees the failure of the organization in the medium or short term.

The lack of knowledge and resources in Ecuador is a barrier to innovation. This lack results in a stagnation of the country's progress, and educational institutions face challenges by not receiving the necessary support for research and teacher updating, an argument supported by (Archibugi & Bizzarri, 2004).

There is a lack of innovation in Ecuador, which has several explanations, one of which is the lack of investment by private companies, which do not allocate budgets for innovative purposes. The reduction on the part of the state budget is another reason that could explain this behavior.

Companies in a region must promote innovation, invest in R&D, and foster collaboration through strategic partnerships. In short, understanding the evolution of consumer tastes and preferences towards innovative products (Ríos-Ríos et al., 2023) is especially true when combined with age groups where younger people are interested in technology and technological innovations.

The work has implications for the construction of public policy, allowing policy makers to increase the information available for the development of innovation policy for Ecuador.

The limitations of this study are centered on the scarce information available in the country on innovation. Absence of indicators or determinants of innovation capacity in companies, together with interruption in the collection of information on activities related to innovation.

As future lines of research, it is recommended to conduct sectorial studies on innovation capacity in the construction and real estate sectors, innovation in transportation, agriculture, forestry, livestock, and fishing, among others, focusing on the 24 provinces belonging to Ecuador, as well as international comparisons.

7. Acknowledgment

7.1 Funding

This research was funded by the Technical University of Ambato. Project: Theoretical-methodological model for the analysis of local innovation ecosystems and its application in the province of Tungurahua.

7.2 Data Availability Statement

All data taken from https://www.ecuadorencifras.gob.ec/encuesta-nacional-de-actividades-de-ciencia-tecnologia-e-innovacion-acti/ accessed on april 2023.

References

Acosta, M., Coronado, D., León, M. ªD, & Moreno, P. J. (2020). The Production of Academic Technological Knowledge: an Exploration at the Research Group Level. *Journal of the Knowledge Economy*, *11*(3), 1003–1025. https://doi.org/10.1007/s13132-019-0586-9

Adikari, AM. P., Liu, H., & Marasinghe, MMSA. (2021). Inward Foreign Direct Investment-Induced Technological Innovation in Sri Lanka? Empirical Evidence Using ARDL Approach. *Sustainability*, *13*(13), 7334. https://doi.org/10.3390/su13137334

Alatrista, A. (2022). Regional Innovation Policy in Latin America: Exploratory Analysis. *Journal of Technology Management and Innovation*, *17*(3), 25–39. https://www.jotmi.org/index.php/GT/article/view/3945

Amable, B., Boyer, R., & Barré, R. (2008). *Los sistemas de innovación en la era de la globalización*. Miño y Dávila Editores.

Archibugi, D., & Bizzarri, K. (2004). Committing to vaccine R&D: A global science policy priority. *Research Policy*, *33*(10), 1657–1671. https://doi.org/10.1016/j.respol.2004.10.003

Archibugi, D., & Coco, A. (2004). A New Indicator of Technological Capabilities for Developed and Developing Countries (ArCo). *World Development*, *32*(4), 629–654. https://doi.org/10.1016/J.WORLDDEV.2003.10.008

Archibugi, D., & Pietrobelli, C. (2003). The globalisation of technology and its implications for developing countries: Windows of opportunity or further burden? *Technological Forecasting and Social Change*, *70*(9), 861–883. https://doi.org/10.1016/S0040-1625(02)00409-2

Arias-Pérez, J., Durango, C., & Millán, N. (2015). Capacidad de innovación de proceso y desempeño innovador: efecto mediador de la capacidad de innovación de producto. Process innovation capability and innovation performance: mediating effect of product innovation capability. *AD-Minister*, *27*, 75–93.

Ashal, N., Crowther, D., & Albadri, F. (2023). Intrapreneurship: A Competent Method Toward Organizations' Sustainability. *Approaches to Global Sustainability, Markets, and Governance*, *Part F811*, 27–45. https://doi.org/10.1007/978-981-99-2456-1_2

Awad, F., Sawaean, A., Anuar, K., & Ali, M. (2020). The impact of entrepreneurial leadership and learning orientation on organizational performance of SMEs: The mediating role of innovation capacity. *Growingscience.Com*, *10*, 369–380. https://doi.org/10.5267/j.msl.2019.8.033

Barona-Zuluaga, B., Rivera-Godoy, J. A., Aguilera-Cifuentes, C. I., & Garizado-Román, P. A. (2015). Financiación de la innovación en Colombia. *Entramado*, *11*(1), 80–93.

Beaudry, C., & Kananian, R. (2013). Follow the (Industry) Money - The Impact of Science Networks and Industry-to-University Contracts on Academic Patenting in Nanotechnology and Biotechnology. *Industry and Innovation*, *20*(3), 241–260. https://doi.org/10.1080/13662716.2013.791125

Boon, W., & Edler, J. (2018). Demand, challenges, and innovation. Making sense of new trends in innovation policy. *Science and Public Policy*, *45*(4), 435–447. https://doi.org/10.1093/SCIPOL/SCY014

Camisón, C., & Villar-López, A. (2014). Organizational innovation as an enabler of technological innovation capabilities and firm performance. *Journal of Business Research*, *67*(1), 2891–2902. https://doi.org/10.1016/j.jbusres.2012.06.004

Carrasco-Carvajal, O., Castillo-Vergara, M., & García-Pérez-de-Lema, D. (2023). Measuring open innovation in SMEs: an overview of current research. *Review of Managerial Science*, *17*(2), 397–442. https://doi.org/10.1007/S11846-022-00533-9

Cevallos, A., Duque, E., & Echeverria, T. (2018). Validación del constructo capacidad de innovación utilizando el análisis factorial confirmatorio en Ecuador. *Espacios*, *39*(11), 24.

Ciriaci, D. (2017). Intangible resources: the relevance of training for European firms' innovative performance. *Economia Politica*, *34*(1), 31–54. https://doi.org/10.1007/s40888-016-0049-8

Cooke, P., Uranga, M. G., & Etxebarria, G. (1997). Regional innovation systems: Institutional and organisational dimensions. *Research Policy*, *26*, 475–491. http://www.sciencedirect.com/science/article/pii/S0048733397000255

Corrente, S., Garcia-Bernabeu, A., ... S. G.-... of I. and, & 2023, undefined. (2021). Robust measurement of innovation performances in Europe with a hierarchy of interacting composite indicators. *Taylor & Francis*, *32*(2), 305–322. https://doi.org/10.1080/10438599.2021.1910815

Crespi, G., Giuliodori, D., Giuliodori, R., & Rodriguez, A. (2016). The effectiveness of tax incentives for R&D+i in developing countries: The case of Argentina. *Research Policy*, *45*(10), 2023–2035. https://doi.org/10.1016/J.RESPOL.2016.07.006

Dehyouri, S., Zand, A., & Arfaee, M. (2024). Study of innovation capacity of fisheries companies in the covid-19 pandemic crisis X1 - Estudo da capacidade de inovação das empresas de pesca na crise da pandemia de covid-19. *Brazilian Journal of Biology*, *84*, e263971–e263971.

Donbesuur, F., Ampong, G. O. A., Owusu-Yirenkyi, D., & Chu, I. (2020). Technological innovation, organizational innovation and international performance of SMEs: The moderating role of domestic institutional environment. *Technological Forecasting and Social Change*, *161*. https://doi.org/10.1016/j.techfore.2020.12025 2

Drucker, P. (2004). La disciplina de la innovación. *Harvard Business Review*, 3–7.

Edquist, C. (2019). Towards a holistic innovation policy: Can the Swedish National Innovation Council (NIC) be a role model? *Research Policy*, *48*(4), 869–879. https://doi.org/10.1016/J.RESPOL.2018.10.008

Ekboir, J., & Parellada, G. (1999). *Algunas reflexiones respecto a los sistemas de innovación en la era de la globalización*.

Forsman, H. (2011). Innovation capacity and innovation development in small enterprises . A comparison between the manufacturing and service sectors. *Research Policy*, *40*(5), 739–750. https://doi.org/10.1016/j.respol.2011.02.003

Furman, J., Porter, M., & Stern, S. (2002). The determinants of national innovative capacity. *Research Policy*, *31*(6), 899–933. https://doi.org/https://doi.org/10.1016/S0048-7333(01)00152-4

García, O., Quintero, J., & Arias-Pérez, J. (2014). Capacidades de innovación, desempeño innovador y desempeño organizacional en empresas del sector servicios. *Cuadernos de Administración*, *27*(49), 87–108.

Hanaysha, J. R., Al-Shaikh, M. E., Joghee, S., & Alzoubi, H. M. (2022). Impact of Innovation Capabilities on Business Sustainability in Small and Medium Enterprises. *FIIB Business Review*, *11*(1), 67–78. https://doi.org/10.1177/23197145211042232

Hidalgo, A. (2011). *La gestión de la innovación como proceso*. 1–24.

Hogan, S. J., Soutar, G. N., McColl-Kennedy, J. R., & Sweeney, J. C. (2011). Reconceptualizing professional service firm innovation capability: Scale development. *Industrial Marketing Management*, *40*(8), 1264–1273. https://doi.org/10.1016/j.indmarman.2011.10.002

Hong, Y., Niu, D., Xiao, B., & Wu, L. (2015). Comprehensive evaluation of the technology innovation capability of China's high-tech industries based on fuzzy borda combination method. *International Journal of Innovation Science*, *7*(3), 215–230. https://doi.org/10.1260/1757-2223.7.3.215

Hu, A. G., & Jefferson, G. H. (2004). Returns to research and development in Chinese industry: Evidence from state-owned enterprises in Beijing. *China Economic Review*, *15*(1), 86–107. https://doi.org/10.1016/S1043-951X(03)00028-2

Ketonen-Oksi, S. (2018). Creating a shared narrative: the use of causal layered analysis to explore value co-creation in a novel service ecosystem. *European Journal of Futures Research*, *6*(1), 5. https://doi.org/10.1186/s40309-018-0135-y

Lee, P. (2012). Transcending the tacit dimension: Patents, relationships, and organizational integration in technology transfer. *California Law Review*, *100*(6), 1503–1572.

Lewis, J. M., Ricard, L. M., & Klijn, E. H. (2018). How innovation drivers, networking and leadership shape public sector innovation capacity. *International Review of Administrative Sciences*, *84*(2), 288–307. https://doi.org/10.1177/0020852317694085

Liu, Y., & Yang, R. (2023). Independent Innovation Capacity of Chinese High-Tech Industries Using CRITIC and TOPSIS Methods. *Journal of Engineering Science and Technology Review*, *16*(1), 18–25. https://doi.org/10.25103/jestr.161.03

Lordén, M., & Morelo, J. (2020). Efecto del gasto en I + D interno en la eficiencia tecnológica de empresas españolas . Análisis comparativo durante el periodo de crisis de 2008-2012 * Efeito das despesas internas em P & D na eficiência tecnológica de empresas espanholas . Análise compar. *CTS*, *15*(44).

Mendoza-Silva, A. (2021). Innovation capability: a systematic literature review. *European Journal of Innovation Management*, *24*(3), 707–734. https://doi.org/10.1108/EJIM-09-2019-0263

Morales, M., Ortíz, C., Duque, Y., & Plata, P. (2016). Estrategias para fortalecer capacidades de innovación: una visión desde micro y pequeñas empresas. *Ciencia, Docencia y Tecnología*, *27*(53), 205–233.

Nathai-Balkissoon, M., Maharaj, C., Guerrero, R., Mahabir, R., & Dialsingh, I. (2017). Pilot development of innovation scales for beverage manufacturing companies in a developing country. *Cogent Business & Management*, *4*(1), 1379214. https://doi.org/10.1080/23311975.2017.1379214

Ngo, L. V., & O'Cass, A. (2012). In search of innovation and customer-related performance superiority: The role of market orientation, marketing capability, and innovation capability interactions. *Journal of Product Innovation Management*, *29*(5), 861–877. https://doi.org/10.1111/j.1540-5885.2012.00939.x

Nonaka, I., & Takeuchi, H. (1995). *La organización creadora de conocimiento. Cómo las compañías japonesas crean la dinámica de la innovación.* Oxford University Press.

Novillo-Villegas, S., Ayala-Andrade, R., Lopez-Cox, J. P., Salazar-Oyaneder, J., & Acosta-Vargas, P. (2022). A Roadmap for Innovation Capacity in Developing Countries. *Sustainability*, *14*(11), 6686. https://doi.org/10.3390/su14116686

OCDE. (2005). *Manual de Oslo. Guía para la recogida e interpretación de datos sobre innovación*.

OECD. (2005). *Oslo Manual: Guidelines for collecting and interpreting innovation data* (Third Edit). OECD Organisation for Economic Co-operation and Development. http://scholar.google.es/scholar?q=Oslo+manual%3A+Guidelines+for+collecting+and+interpreting+innovation+data&btnG=&hl=es&as_sdt=0%2C5#0

OECD. (2018). *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation. The Measurement of Scientific, Technological and Innovation Activities* (4th Editio). OECD. https://doi.org/10.1787/9789264304604-en

OMPI. (2022). Global Innovation Index 2022. *Global Innovation Index 2022*, 1–14.

Ortiz, F., Brito, E., & Ovalles, M. (2007). Sistema de medición de la capacidad de innovación tecnológica aplicado a una empresa manufacturera. *Universidad, Ciencia y Tecnología*, *11*(42), 13–20.

Porter, M. (1990). The Competitive Advantage of Nations. In *Journal of Management*. https://doi.org/10.1177/014920639101700113

Ríos-Ríos, S., Ochoa-Paredes, F., Uribe-Hernández, Y., Moran-Requena, H., & Pacheco-Sánchez, D. (2023). Effect of the millennial 2.0 entrepreneurship program on the technological innovation capacity of the students at the Universidad Nacional de Cañete. *International Journal of Advanced and Applied Sciences*, *10*(1), 84–91.

Robayo, P. (2016). La innovación como proceso y su gestión en la organización: una aplicación para el sector gráfico colombiano. *Suma de Negocios*, *7*(16), 125–140. https://doi.org/10.1016/j.sumneg.2016.02.007

Saari, E., Lehtonen, M., & Toivonen, M. (2015). Making bottom-up and top-down processes meet in public innovation. *Service Industries Journal*, *35*(6), 325–344. https://doi.org/10.1080/02642069.2015.1003369

Salazar-Elena, J., Sánchez, M., & Otamendi, F. (2016). A Non-Parametric Delphi Approach to Foster Innovation Policy Debate in Spain. *Sustainability*, *8*(5), 487. https://doi.org/10.3390/su8050487

Sánchez, J. C. (2011). La innovación: una revisión teórica desde la perspectiva de marketing. *Perspectivas*, *27*, 47–71.

Schot, J., & Steinmueller, W. E. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy*, *47*(9), 1554–1567. https://doi.org/10.1016/J.RESPOL.2018.08.011

Schumpeter, J. (1934). *Theory of Economic Development*.

Schumpeter, J. (1947). The creative response in economic history. *The Journal of Economic History*, *7*(2), 149–159. http://journals.cambridge.org/abstract_S0022050700054279

Shen, X., & Lin, B. (2020). Policy incentives, R&D investment, and the energy intensity of China's manufacturing sector. *Journal of Cleaner Production*, *255*. https://doi.org/10.1016/j.jclepro.2020.120208

Smith, A. (1776). *The wealth of nations* (p. 818).

Smith, N., & Thomas, E. (2017). Regional conditions and innovation in Russia: the impact of foreign direct investment and absorptive capacity. *Regional Studies*, *51*(9), 1412–1428. https://doi.org/10.1080/00343404.2016.1164307

Sun, C., Khan, A., & Ren, Y. (2023). Empowering Progress: Education, innovations and financial development in the battle against energy poverty. *Journal of Cleaner Production*, *425*, 138941. https://doi.org/10.1016/J.JCLEPRO.2023.138941

Watkins, A., Papaioannou, T., Mugwagwa, J., & Kale, D. (2015). National innovation systems and the intermediary role of industry associations in building institutional capacities for innovation in developing countries: A critical review of the literature. *Research Policy*, *44*(8), 1407–1418. https://doi.org/10.1016/j.respol.2015.05.004

Yam, R., Lo, W., Tang, E., & Lau, A. (2011). Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries. *Research Policy*, *40*(3), 391–402. https://doi.org/10.1016/j.respol.2010.10.013

Zastempowski, M., & Cyfert, S. (2022). The role of strategic innovation activities in creating Spanish agriculture companies' innovativeness. *Agricultural Economics (Czech Republic)*, *68*(6), 230–238. https://doi.org/10.17221/66/2022-AGRICECON