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Cooperation for Innovation: Main Drivers in Countries with Low Levels of Innovation

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ABSTRACT: This study seeks to identify the factors that drive business innovation by analysing innovation ecosystems from a collaborative perspective in countries with low levels of innovative activity. The study included more than 6,000 companies included in the EDIT 2020 survey conducted by DANE, the agency responsible for official statistics in Colombia. Artificial intelligence techniques such as machine learning were used to process the information. The main findings emphasise the importance of effectively managing internally developed knowledge and diversifying external sources of information.

KEYWORDS: Innovation Results, Cooperation, Machine Learning, Resources.

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Introduction

In recent years, the concept of innovation has gained importance both in academic circles and within companies due to its role in the face of more demanding market conditions, with rapid technological changes, scarce resources and a more informed customer, which requires proactive companies in search of innovation, growth and efficiency even to survive (Damanpour, 1991).

The European Union (EU) has long recognised the importance of innovation in driving economic growth. Policies such as the Lisbon Strategy and the Europe 2020 Strategy have emphasised research-based innovation, with targets such as investing 3% of GDP in R&D (Europe 2020, 2010). However, the effectiveness of these policies in increasing innovation performance, especially for SMEs, is the focus of debate due to the specific challenges they face.

In Latin America, emerging economies like Colombia base their growth on primary sector products with little added value, which limits the development and transfer of innovation and thus hinders competitiveness and adaptability to new technologies. These emerging economies must move toward technological convergence, which enables developing countries or regions to gradually close technological gaps with developed countries through their own efforts in the technological development process, thereby surpassing developed countries (Hou, 2020).

For emerging economies with limited access to resources, innovation is crucial in raising macro-level productivity levels compared to other economies, enabling their companies to transition from an investment-based innovation strategy to a growth-oriented strategy.

Literature review

From a theoretical perspective, the Resource-Based View (RBV) broadly explains the impact of innovation on the development of companies, based on the integration of various external resources in a framework that seeks to produce synergistic effects to improve internal advantages (Xie et al., 2022), obtaining different forms of innovation (Peiró-Signes et al., 2022). Cooperation for innovation refers to the participation of an external agent in the company's innovative activities (Li-Ying et al., 2018), primarily due to the lack of internal knowledge and capabilities that necessitate its incorporation through cooperation (Diez-Martínez et al., 2022).

This collaboration is carried out with institutional allies (i.e., government entities, universities and research centres) (Kleine et al., 2022)and with allies linked to the market (i.e., suppliers, customers and competitors) (Kafouros et al., 2020)seeking to develop new products, better distribution, greater manufacturing flexibility and compliance with regulations (Najafi-Tavani et al., 2018).

Research questions

To date, most innovation studies have been conducted in companies located in stable, highly developed economies, with a smaller number of studies focusing on companies in emerging economies

with highly competitive economic sectors (Xu et al., 2021). To a greater extent, studies confirm the positive effect of cooperation on companies' innovation performance (Freire & Gonçalves, 2021), which is related to the quantity and quality of the knowledge acquired.

Developed countries, unlike emerging ones, are characterised by mature institutions (politically and geographically homogeneous), innovation systems with strong interconnections between actors, world-class universities, and solid indigenous research and development (R&D) capabilities (Kafouros et al., 2015). With this in mind, our work seeks to address the following question: What are the primary drivers of business cooperation in countries with low levels of innovation?

Methodology

This study is based on data from the 2020 Survey of Technological Development and Innovation in the Manufacturing Industry (EDIT), prepared by the National Administrative Department of Statistics (DANE) of Colombia. The EDIT is a key source of statistical data on the scientific, technological, and innovation activities of manufacturing firms in Colombia. For this study, we classified firms as innovative, following the definitions in the Oslo Manual (2005), if they introduced at least one new or significantly improved product or service, implemented a new or significantly improved process, or adopted a new organisational or marketing method during the reference period. Firms that did not introduce any of these innovations were classified as non-innovative. The Colombian manufacturing sector exhibits a relatively low innovation capacity compared to other countries: only 1,655 companies (24.35%) of the sample reported innovations, while 5,143 companies (75.65%) did not innovate during the period.

To identify the factors driving a company's ability to achieve innovative outcomes and assess their relative importance and the direction of their impact, we employ the XGBoost algorithm. This machine learning technique offers several advantages over traditional multivariate approaches.

The analysis presented is part of a larger project that includes the analysis of variables such as labour, investment, financing, barrier types, and others. Specifically, in this paper, we will present the results using those variables related to cooperation in companies as predictors.

Results

Model interpretation involves evaluating both its performance and the role of various predictors in determining its outcomes. Model quality is measured by its predictive accuracy, that is, its ability to correctly classify cases. In the confusion matrix [Figure 1], diagonal entries show correct classifications made by the model, while off-diagonal entries represent misclassifications. The model correctly classified 96.5% of cases, significantly exceeding the proportionality and maximum likelihood criteria recommended for multivariate classification techniques (Hair et al., 2014). SHAP scores provide a measure of the average contribution of each feature to the model's predictions. [Figure 2] summarises the average contribution of each predictor, while [Figure 3] offers additional insight by showing the direction and distribution of the SHAP scores. We employ Shapley (SHAP) scores, as this is a widely

accepted method for interpreting complex models.

Figure 1

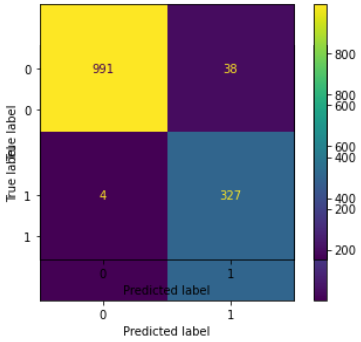


Figure 2

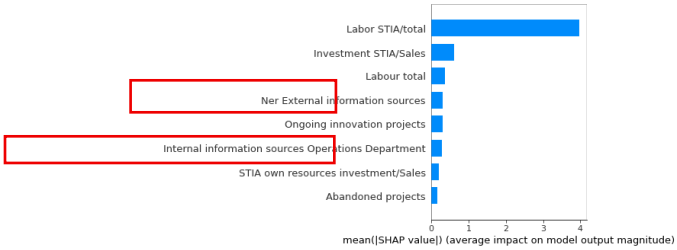
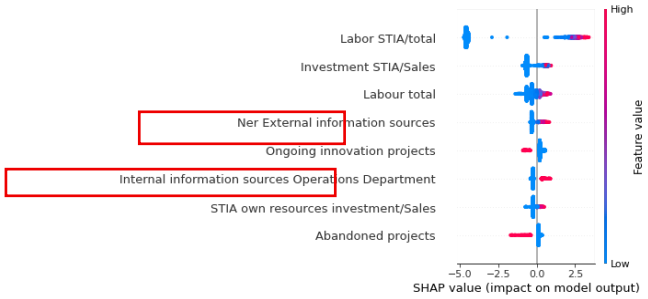


Figure 3



The results indicate that companies that use external sources, particularly those that rely on more than two types of external information, are more likely to report innovation results. Furthermore, companies that value internal information from their Operations Department as a key source of innovation are also more likely to be innovative. Furthermore, the type of partner or information source (Institutional-Market), the geographic origin (Local-Foreign), and the objective of the cooperation do not significantly contribute to the model's predictions.

Conclusions

Unlike findings in highly innovative regions, where ecosystem-driven factors such as collaboration and public-private partnerships act as central drivers of innovation (Hervás-Oliver et al., 2021), this study demonstrates a limited influence of these aspects in low-innovation contexts such as Colombia.

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