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Different Ways to Access Knowledge for Sustainability-Oriented Innovation. The Effect of Foreign Direct Investment

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Abstract: Sustainability-oriented innovation (SOI), which displays an intention to develop a product or service that contributes to economic, environmental, and social sustainability, has drawn growing institutional and academic attention, due to the general consideration that innovation is an essential part of achieving sustainability. For developments of this nature, it is considered that foreign direct investment (FDI) helps companies to meet the requirements demanded by SOI, however, they show different cooperation patterns, and so it is not known what path they must take to achieve it. In this context, this paper uses comparative analysis to try to shed light on the possible differences in the paths taken to achieve SOI by companies with and without FDI, taking into account their different form of knowledge management. To achieve this objective, it has been necessary to build new sustainability indicators (economic, environmental, and social) that allow the evaluation of the sustainability of these processes, considering the sustainability objectives that guided companies towards innovation. Using a logit model for 5897 Spanish companies during the period 2009–2014, this paper contributes both theoretically and empirically to emerging research into the opening of sustainable innovation. It provides a better understanding of the different channels for accessing knowledge for SOI, and examining these channels through absorptive capacity and cooperation, according to its age and size.

Keywords: sustainability-oriented innovation; foreign direct investment; sustainable indicators; cooperation; absorptive capacity; size; age

1. Introduction

The literature widely expounds the idea that innovation can be driven by sustainability. However, such innovation has great complexity, due to its increased sophistication in learning and innovation networks [1]. This poses a challenge that companies cannot rise to by themselves, making it imperative they search for knowledge beyond their borders [2].

Sustainability-oriented innovation (SOI) has become an information- and learning-related challenge [3]. This implies that companies with efficient knowledge management processes see these innovations being pushed forward [4], as they have the ability to identify and access the knowledge needed to frame the innovations within the principles of sustainability [5], thanks to their skills, specialist staff, or because they can import specialized knowledge [6].

Current literature, therefore, focuses on understanding how companies expand and exploit their external links in the interest of sustainability, which includes the development of cooperation with external partners [3]. The diversity of the current channels to achieving sustainability creates a need to integrate a large number of actors, but within a sustainable context [7].

Despite this emphasis, the way in which different potential suppliers of knowledge, including providers [8], clients [9], consultants [10], competitors [11], and universities [12], can contribute to SOI, is not clear [13]. In addition, the intrinsic multidimensionality of sustainable goals, as well as their scattered effects on innovation, make assessing innovations, with respect to sustainability, a highly complex task [14]. To gain a full understanding of the complexity of sustainability requires the construction of composite indicators, which enable its evaluation and increase its scope [15].

This paper focuses on understanding how companies expand and exploit their external links in the interest of sustainability, answering the question: **are there different ways to access knowledge for SOI?** To achieve this goal, we have developed new sustainability indicators (economic, environmental, and social) that enable these processes to be assessed from the perspective of sustainability, considering the sustainability goals that oriented the companies towards innovation, and determining whether or not they influence innovation and whether or not this is enhanced by cooperation with any of the aforementioned knowledge sources.

As has been established, when developing their innovation strategies, companies can rise to the challenge of sustainability, and create a competitive advantage [16]. To do this, they must be capable of meeting a series of requirements demanded by SOI, which include technological and financial capacity, the ability to manage and create alliances and respond to market risk and directional risk, and the absorptive capacity to recognize this as an advantage [17].

In this context, foreign direct investment (FDI) (a company is considered as having FDI, when foreign investment exceeds 10%) can be considered as a driving factor behind sustainable development, through its capacity to influence the wellbeing of societies [18], as it contributes knowledge assets [19], represents a stable and resistant form of financing [20], and leads to benefits in terms of know-how and demand creation [21]. It could also be a good catalyst for domestic investment, complement local resources, and provide confidence [22], which results in an improved image and, in turn, financial intermediation and credit growth [23], generating new employment opportunities and facilitating technology transfer and management capacity [24].

Therefore, having FDI can make these companies more likely to develop this type of innovation [17]. However, companies with FDI differ from their counterparts without it in terms of their capacity to benefit from the different partners in R&D [25]. Given this difference, this paper analyzes how partnerships, in the interest of sustainability, affect these companies differently. With this in mind, this paper attempts to answer the question: **how does having FDI affect the pathways for accessing knowledge for SOI?**

This comparison is interesting to study, given that there are very few studies that analyze the multiple types of partners for innovation [26]. Furthermore, since the search strategies of companies with FDI are determined by private aims, which orient their activities towards innovation [27], analyzing the influence of multiple partners in SOI means that the lessons learnt from studies on R&D cooperation may need modifying, in order to explain the behavior of both types of company.

This paper hopes to contribute, both theoretically and empirically, to emerging research into sustainable innovation, while also providing a better understanding of the different channels for accessing knowledge for attaining SOI. To do this, we examined these pathways in terms of absorptive capacity and cooperation, according to company age and size, in a comparative analysis between foreign and domestic companies in an intermediate country such as Spain.

The paper is structured as follows, in the next section, corresponding to the second section; the conceptual framework is established through a review of the literature. The third section presents the empirical study. The fourth section shows the results empirically and graphically. The fifth section is a discussion on the main results obtained. The sixth and last section develops the conclusions drawn from the study, as well as future research lines and the paper's limitations.

2. Theoretical Framework

The belief that companies' sustainable activities provide profit is increasingly widespread among business managers [28]. However, these activities, as they take into account the environmental and social dimensions, as well as the economic one, entail greater risk [29]. As indicated by Ardito and Dangelico [30], there may be effects of different firm strategic and organizational orientations on several dimensions of sustainable performance. This is why sustainability-oriented innovation must be seen as the direction to follow, and not a final destination [31], thereby inherently leading us to the understanding that a company's innovative activity should be oriented towards sustainable goals.

Since innovations can be very recent, thereby impeding the assessment of their real impact on sustainable development, we have decided to include, as a key assessment factor, the intention of the company when developing a product or service, which contributes towards environmental and social sustainability. Hence, this paper's use of the term "sustainability-oriented innovation" or SOI, to refer to new or significantly improved products or services which contribute to economic, environmental, and social sustainability [32].

However, the intrinsic multidimensionality of sustainable goals, as well as their scattered effects on innovation, make assessing innovations, with respect to sustainability, a highly complex task [14]. To gain a full understanding of the complexity of sustainability requires the construction of composite indicators, which enable its evaluation and increase its scope [15].

These sustainable indicators allow us to quantify, analyze, and transmit information in a simple way, optimizing the initial information [33] and informing as to whether this sustainable dimension has been attained. To do this, these indicators must be workable, measurable, relevant, specific and quantitative, and have data availability [34].

The sustainability indicators, constructed in this paper, have been based on a broad literary review classified according to the three impact areas defined by this concept: economic, environmental, and social (see Table 1).

Table 1. Review of the literature on sustainable criteria.

Factor	Items	Authors
Economic sustainability criteria	Market shares	[35–47]
	Production	
	Commercial opportunities	
Environmental sustainability criteria	Use of energy	[34–39]
	Use of materials	[41]
	Environmental impact	[44–57]
	Compliance with environmental regulations	
Social sustainability criteria	Customer satisfaction	[34–40]
	Employee health	
	Employee security	[44–46]
	Employment creation	[48–50]
	Employment stability	[54–58]
	Qualified jobs	

Source: prepared by the authors.

Together with these sustainability indicators, within the evident multidimensionality derived from the concept of sustainable development, learning is key regarding the increase in competition in the sphere of SOI [59]. Learning that fosters sustainability is understood as the application of the value provided by new knowledge and its assimilation [60]. In this regard, there is a recognition of the importance of the involvement of foreign partners, who provide new pathways and knowledge, offering useful learning to successfully establish new foci regarding sustainability.

Along similar lines, diverse studies show a greater propensity to innovate sustainably, thanks to external sources of knowledge and cooperation agreements [61]. The cooperation allows a company to diversify risks, attain costly skills, and reduce development time, even in companies with strong

internal R&D activities, and with a high level of human capital [62]. However, there is no consensus on the ideal type of cooperation for achieving each of the dimensions of sustainability (Table 2).

Table 2. Studies on the relationship between cooperation and sustainable innovation.

Authors	Purpose	Actors Involved	Result	Methodology
[7]	To examine open innovation capabilities when innovations are particularly focused on sustainable development	Research institution Employees Users Suppliers External agents Competitors	For innovations to develop a sustainable product or service, preestablished, open conventional innovation capabilities can be used	Multiple-case study
[63]	This paper investigates the ability of sustainability-oriented small and medium-sized enterprises to acquire and develop explicit knowledge required for an environmental management system and related tools	Strategic alliances with suppliers and customers	Proactive approaches to acquiring knowledge are complemented by structured interaction with external stakeholders	Qualitative interviews and content analyses
[64]	This paper explores the case of a Brazilian family-owned company of rubber-based products, operating in the sectors of health, education, and coatings, which, based on organizational sustainability, uses knowledge to develop open innovations aimed at promoting sustainable innovation	Customers Industry Schools in the region and the country Health professionals Suppliers	Organizational survival depends directly on the actions of creating new ideas and innovation cycles and, moreover, allowing interaction among stakeholders	Exploratory single case study
[61]	To find out the effect of university-business interactions on the performance of SOI in SMEs	Universities	The interaction between Universities and Business leads to greater productivity and sales of SOI	Structural equation modelling
[65]	This paper deals with the open innovation mode in the environmental realm and investigates the effects that knowledge sourcing has on firms' environmental innovations	Cooperation without distinction of partner Depth, as the number of external sources of information to which the company attributes a high degree of importance Diversity, as the number of information sources from external companies that depend on the company for their innovation activities	Both the variety and the intensity of the company's search for external knowledge can help the decision to introduce an environmental innovation	Hierarchical econometric models
[62]	To provide a comprehensive framework for understanding the specific role of—internal, external and hybrid—resources in environmental innovation	External companies or institutions	Green innovators seem to be characterised by more intensive external relationships	Probit models
[9]	To create a methodological framework to accompany the innovation of sustainable product services	Customers	Strong influence of user habits on the consumption of heating energy and shows the starting points for the development of sustainable product services	Case study
[1]	This paper connected responsible innovation with open knowledge networks	Opening capacity Diversity opening	Responsible innovation drives openness with regard to capacity and diversity	Exploratory quantitative approach and case study
[2]	To integrate knowledge and competencies from outside of the firm on green product development	Collaboration networks External knowledge links	External knowledge links play a key role in the integration of principles of environmental sustainability into the manufacturing process	Regression analysis in two steps

Table 2. Cont.

Authors	Purpose	Actors Involved	Result	Methodology
[66]	This paper investigates how green innovators address the knowledge needs that emerge when initiating a pathway of sustainability	Important as a source of information for: Suppliers Clientele Competitors KIBS Universities Public research centres Others Diversity of cooperation Cooperation with foreign partners (% of companies)	The authors' results suggest that the development of EIs entails a higher recourse to external knowledge, in the form of the use of external information sources, acquiring R&D from external firms and cooperation. Relationships with partners that do not belong to the supply chain—including KIBS, universities, research institutions and competitors—are far more important than for other innovations	ANOVA
[67]	This paper explores the role of suppliers in enhancing the manufacturer's ability to successfully carry out green innovation in product development	Suppliers	There is a strong link between environmental compliance and new green product developments. Involving key suppliers in green new product development for environmentally demanding customers and markets can bring both environmental and commercial success	Case study

Source: prepared by the authors.

From this literary review, companies with a greater propensity for SOI are those that go beyond their own limits through alliances with stakeholders [68], which implies identifying, exploring, and integrating their viewpoints [2]. Acknowledging that, the companies' challenge is how to recreate new managerial and organizational capabilities for innovating towards sustainability [69]. However, this requires companies to be in a state of alert [70], and having a high enough absorptive capacity becomes a central skill for SOI [66].

Therefore, internal knowledge will be the source of a company's absorptive capacity, which will be strengthened by managers through internal R&D and links with external information sources [71]. Consequently, certain studies have involved human capital when it comes to internalizing external knowledge [72], but very few have taken into account the characteristics of this capital empirically [73].

In addition, since absorptive capacity correlates with inputs to the innovative process, the way to isolate its role is by analyzing its moderating function in the impact of external knowledge flows and the results of innovation [65], highlighting it as a complementary factor in the search for this knowledge [74]. Since mere exposure to knowledge is not enough, what is required is to retain, reactivate, and apply it to products and processes [75].

As has been established in the introduction, FDI helps companies to meet the requirements demanded by SOI. In fact, for FDI, the search for economic performance is not the only channel, since environmental and social concerns are also now being addressed [76]. It, therefore, does not only cover investments in physical facilities, but also any activity that is relevant in value creation, such as knowledge attainment [77].

It is considered that FDI seeks out strategies to increase knowledge with the aim of gaining strategic resources for its localization [78]. This means that because of its potential to invest in knowledge [79], its attitude towards cooperation and interest in obtaining external knowledge [80] are technologically different, and also favors an increase in human capital and competition [81].

This strategy leads FDI to search for and develop knowledge assets through diverse channels [82]. However, the extent to which this happens is dependent on the integration of these companies, both internally and externally [83], enabling them to become part of the local innovation system [84].

Thus, the beneficial formation of external links with other companies and institutions in their environment allows companies to be more independent from their corporate group, as well as to be

more creative [85]. In this sense, the literature shows that there are different cooperation patterns, in the case of innovation, not oriented by sustainable objectives with respect to national companies, taking into account multinationality, the diversity of partners, the sector, whether it deals with internal or external innovation, the search strategy for external knowledge, and in different settings, such as Spain, Italy, Finland, and the Netherlands (Table 3).

Table 3. Cooperation patterns of foreign vs. national companies.

Authors	Purpose	Cooperation	Difference	Methodology
[86]	To explore the effects of multinationality on the propensity to R&D cooperation, considering subsidiaries of foreign MNEs and domestic owned MNEs	Cooperation with Italian counterparts Cooperation with foreign counterparts	Foreign MNEs are better at R&D cooperation with foreign partners, but it is domestic-owned MNEs that exhibit the highest propensity to R&D cooperation with local firms. By contrast, foreign MNEs have much the same propensity to enter local R&D cooperation as non-MNEs	Probit regressions with random effects
[25]	To analyze how research and development (R&D) cooperation affects product innovation for subsidiaries of foreign multinational firms and domestic firms	Universities Customers Suppliers Competitors	Subsidiaries may benefit more from undertaking R&D cooperation with customers and competitors, whose deeper knowledge of local conditions better complements the more global knowledge base of subsidiaries. In contrast, domestic firms may benefit more from engaging in R&D cooperation with suppliers and universities, whose more global nature of knowledge better complement the deeper local knowledge base of domestic firms	Probit regressions with random effects
[87]	To contribute a better understanding of cooperative innovation patterns of foreign subsidiaries in Spain, looking more closely at sectoral taxonomy. Attention is focused more on innovative intensive subsidiaries and innovation and structural-competitive variables are combined to explain local cooperation	Company has cooperated with external partners (own business group excluded) located in Spain	More intense cooperation of FS with local agents in dynamic specialisation sectors. Cooperative activities are influenced by economic-structural factors of the Spanish economy. Cooperative strategies of domestic firms might also have an influence on those foreign subsidiaries	Logit
[88]	To explore differences between the propensity to cooperate with universities of foreign subsidiaries and Spanish firms	Universities	Relevant differences between foreign subsidiaries and local groups or companies in terms of their propensity to cooperate with universities	Probit Case study
[89]	To understand the relationship between foreign status and local cooperation for innovation	Company has cooperated with external partners (own business group excluded) located in Spain Extent of local cooperative activities Local R&D networks	Foreign status increases the probability of local cooperation for innovation	Logit
[26]	To compare the technology sourcing of foreign subsidiaries and domestic firms looking at domestic R&D outsourcing, international R&D outsourcing, domestic cooperation for innovation and international cooperation for innovation	Cooperation with an unaffiliated partner in Spain Cooperation with an unaffiliated partner in another country	Foreign subsidiaries show a lesser propensity for external technology sourcing via R&D outsourcing from independent firms in the host country, for international R&D outsourcing and for international cooperation for innovation. In contrast, foreign subsidiaries show a greater propensity for domestic cooperation for innovation	Multivariate probit

Table 3. Cont.

Authors	Purpose	Cooperation	Difference	Methodology
[27]	To examine how the search strategy for external knowledge differs between domestic companies in Spain and foreign subsidiaries from developed and developing countries	Companies with external R&D collaboration agreements	Subsidiaries from developing countries draw upon more external knowledge sources than subsidiaries from developed countries; while both types of firms have a less intensive search strategy than domestic firms	Tobit
[90]	To investigate domestic and foreign innovating firms' determinants of R&D cooperation with domestic universities and public knowledge institutes in Finland and the Netherlands	R&D cooperation with domestic public knowledge institutions	Foreign firms in the Netherlands are less likely to cooperate with domestic public knowledge institutions than domestic firms, while in Finland no significant difference can be detected	Heckman probit estimates

Source: prepared by the authors.

This review shows that the patterns of cooperation differ from one company type to the other as regards innovation, but does not inquire as to whether the intention of companies, when developing innovation, is to contribute or not to economic, environmental, and social sustainability. This intention, to achieve the three sustainable objectives when developing innovation, is what makes the difference between what is considered conventional innovation and sustainability-oriented innovation. To the best of our knowledge, there are no studies that analyze these differences for the case of SOI. We, therefore, believe that a study in this line would be useful, bearing in mind cooperation is affected by the complexity of SOI, since it implies moving away from the current knowledge base [69], and that the cooperation networks are more complex [1].

3. Methodology

3.1. Database and Sample

For the study, data has been used from the Technological Innovation Panel (PITEC), which monitors innovation activities, providing anonymized data for both foreign and national companies located in Spain. The database is managed by Spain's National Statistics Institute (INE), and responds to the framework of the Community Innovation Survey (CIS), used to find out the level of innovation in the European Union and Norway (for further information on the methodology for producing, see http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176755&menu=resultados&secc=1254736195616&idp=1254735576669).

From the annual data contained in the panel, the period 2009–2014 has been used for this study, which contains constant and standardized information on 5897 companies, i.e., those companies in operation throughout the sample period, and which have consistently either received or not received FDI. To reach this final sample, we undertook an exhaustive transformation and cleansing of data, leaving aside public companies, research associations and institutions [26], and joint enterprises (companies that have alternated years with and without FDI), as well as companies that were not in operation throughout the sample period. The sample companies were, thereby, classified into two groups, companies with foreign investment (FDI) and without it (NFDI).

This database has certain characteristics that are significant for the purposes of this paper. Firstly, contrary to other European experiences with CIS, PITEC is designed as a panel survey, in other words, it collects information annually from a stable sample enabling the possibility of observing a specific company at various points in time [88]. Monitoring information on the same companies over time is essential for a moderation analysis. Given that a properly defined mediation model establishes causal relationships between variables, the temporal precedence of causal factors is required [91]. Secondly, being a panel survey, the dataset enabled us to control possible endogeneity issues arising from the omission of non-observable characteristics specific to the company [62]. Thirdly, it allowed us to obtain information on R&D cooperation agreements in which companies participated during the period

between $t - 2$ and t , that is, between the reference year of the survey and the previous two [91]. Lastly, the fact that the survey was not conducted specifically to gather information on sustainability issues avoids the potential bias of companies looking to improve their social image [62].

Finally, the study has been focused on Spain, due to various factors which make it, empirically speaking, the ideal stage for this research. The first is that Spain is one of the countries where R&D investment by foreign companies is especially high [27], revealing a high degree of local integration [26]. Secondly, we are focusing on Spain as a paradigm of an intermediate country [89], so an analysis of companies in Spain can, therefore, help to generalize outcomes for a number of countries which, like Spain, are neither in the vanguard nor lagging behind in technological development [25]. Lastly, the growing importance of sustainable issues makes it an interesting context for researching the dynamics of sustainable innovation [92].

3.2. Specification of the Model

Given that the dependent variable is a dichotomous variable, a binary result model is used that controls the possible selection bias that arises from the exclusion of the analysis of companies that are not innovative. This method has proven to be suitable for estimating real results and more suitable than a Heckman selection model, given that the dependent variable is binary and not continuous [8,93,94].

We, therefore, undertook a binary logistic regression analysis, through block selection, using a forward conditional method for the selection of variables. This gave rise to a hierarchical model, so all the variables and interactions are compiled within the table, which contribute to the model's overall adjustment, based on the relevance of the Rao score statistic [95].

The likelihood that a company becomes innovative is calculated using a logistic cumulative distribution function, where the conditional probability has the following form:

$$P_i = P_R((Y = 1|X_i) = \int_{-\infty}^{\beta'X} \varphi(z)dz = \frac{1}{1 + e^{-z}}, \quad (1)$$

where the logit model is the logarithm of the odds ratio:

$$Li = \text{Ln} \left[\frac{P_i}{1 - P_i} \right] = z_i. \quad (2)$$

The model expressed in its general form, taking into account the groups of variables that will be analyzed in the study, is the following:

$$R + D + i_{it} = \text{Ln} \left[\frac{P_i}{1 - P_i} \right] = \alpha_0 + \varphi \text{Control.V} + \gamma \text{ISO} + \delta \text{Coop} + \theta \text{CA} + \mu \text{Moderating.V}, \quad (3)$$

where:

Control.V: Control variables of the model, which are the variables of the Size (T_{ait}) and Antiquity (A_{bit}) of the companies, so $\text{Control.V} = \sum_{a=1}^4 \beta_a S_{ait} + \sum_{b=1}^3 \delta_b A_{bit}$.

ISO: Indicators of sustainable objectives that would be expressed in the equation as $\gamma \text{ISO} = \sum_{f=1}^3 \gamma_f \text{ISO}_{fit}$. These variables are the ones that determine if the companies carry out innovations guided by sustainable objectives.

Coop: Cooperation variables that include six types of partners with which companies can cooperate, their expression being disaggregated in the model $\delta \text{Coop} = \sum_{d=1}^6 \delta_d C_{dit}$.

CA: Variables that define the absorptive capacity of companies in two groups, Human Capital (P_{eit}) and Information Sources (I_{cit}), so that $\theta \text{CA} = \sum_{c=1}^6 \gamma_c I_{cit} + \sum_{e=1}^4 \mu_e P_{eit}$.

Moderating.V: This group is formed by the variables that reflect the moderating effect between the variables of human capital, cooperation, and indicators of sustainable objectives.

Therefore, the Model (3) to estimate in a disaggregated way will be

$$R + D + i_{it} = \text{Ln} \left[\frac{P_i}{1-P_i} \right] = \alpha_0 + \sum_{a=1}^4 \beta_a S_{ait} + \sum_{b=1}^3 \kappa_b A_{bit} + \sum_{f=1}^3 \gamma_f \text{ISO}_{fit} + \sum_{d=1}^6 \delta_d C_{dit} + \sum_{c=1}^6 \gamma_d I_{cit} + \sum_{e=1}^4 \mu_e P_{eit} + \sum_{d=1}^6 \sum_{e=1}^4 \delta_d C_{dit} \cdot \mu_e P_{eit} + \sum_{f=1}^3 \sum_{e=1}^4 \gamma_f \text{ISO}_{fit} \cdot \mu_e P_{eit} + \sum_{d=1}^6 \sum_{f=1}^3 \delta_d C_{dit} \cdot \gamma_f \text{ISO}_{fit} + \sum_{d=1}^6 \sum_{e=1}^4 \sum_{f=1}^3 \delta_d C_{dit} \cdot \mu_e P_{eit} \cdot \gamma_f \text{ISO}_{fit}. \quad (4)$$

Lastly, as has already been mentioned, the Equation (4) has been estimated for two groups, FDI and NFDI, based on whether or not the company has foreign direct investment, respectively (this division has been made taking into account the content of the “company type” question, which forms the PITEC base). We will, therefore, have different equations depending on the groups considered above:

$$R + D + i_{it}(\text{FDI}) = \text{Ln} \left[\frac{P_i}{1-P_i} \right] = \alpha_0 + \sum_{a=1}^4 \beta_a S_{ait} + \sum_{b=1}^3 \kappa_b A_{bit} + \sum_{f=1}^3 \gamma_f \text{ISO}_{fit} + \sum_{d=1}^6 \delta_d C_{dit} + \sum_{c=1}^6 \gamma_d I_{cit} + \sum_{e=1}^4 \mu_e P_{eit} + \sum_{d=1}^6 \sum_{e=1}^4 \delta_d C_{dit} \cdot \mu_e P_{eit} + \sum_{f=1}^3 \sum_{e=1}^4 \gamma_f \text{ISO}_{fit} \cdot \mu_e P_{eit} + \sum_{d=1}^6 \sum_{f=1}^3 \delta_d C_{dit} \cdot \gamma_f \text{ISO}_{fit} + \sum_{d=1}^6 \sum_{e=1}^4 \sum_{f=1}^3 \delta_d C_{dit} \cdot \mu_e P_{eit} \cdot \gamma_f \text{ISO}_{fit}, \quad (5)$$

$$R + D + i_{it}(\text{NFDI}) = \text{Ln} \left[\frac{P_i}{1-P_i} \right] = \alpha_0 + \sum_{a=1}^4 \beta_a S_{ait} + \sum_{b=1}^3 \kappa_b A_{bit} + \sum_{f=1}^3 \gamma_f \text{ISO}_{fit} + \sum_{d=1}^6 \delta_d C_{dit} + \sum_{c=1}^6 \gamma_d I_{cit} + \sum_{e=1}^4 \mu_e P_{eit} + \sum_{d=1}^6 \sum_{e=1}^4 \delta_d C_{dit} \cdot \mu_e P_{eit} + \sum_{f=1}^3 \sum_{e=1}^4 \gamma_f \text{ISO}_{fit} \cdot \mu_e P_{eit} + \sum_{d=1}^6 \sum_{f=1}^3 \delta_d C_{dit} \cdot \gamma_f \text{ISO}_{fit} + \sum_{d=1}^6 \sum_{e=1}^4 \sum_{f=1}^3 \delta_d C_{dit} \cdot \mu_e P_{eit} \cdot \gamma_f \text{ISO}_{fit}. \quad (6)$$

3.3. Identification, Measurement, and Relationship of the Variables

This section presents the definitions and measurements of the variables for this study. For more information see Appendix A.

3.3.1. Sustainability-Oriented Innovations (SOI)

The “internal innovation” ($R + D + i_{it}$) is the dependent variable of the model, measured as a dichotomous variable, which includes the value 1, which indicates whether the company “i” has systematically carried out creative works with the objective of developing new products (goods/services) and new, or significantly improved, processes at the time “t”.

If such innovation has been guided by sustainable goals, we can say that it is an SOI [13]. This is why we have incorporated “indicators of sustainable objectives” (ISO_{fit}) as an explanatory variable, which includes economic, environmental, and social sustainability.

These indicators of sustainable objectives have been developed based on a principal component analysis. This aims to reduce the volume of data and maintain the variation of the initial dataset, hence, its transformation into a new set of variables, which are uncorrelated and classified in such a way that the first conserves most of the variation of the rest of the original variables [96]. The results of this technique are often expressed in terms of scores of components and loadings [97]. It also reduces the risk of double weighting [98], making it an appropriate technique for developing sustainability indicators [56].

The reliability of the scale was demonstrated by calculating its Cronbach’s alpha, which gave the validity and reliability results presented in Appendix B. The result of the factor analysis supports the validity of the three subconstructions for both groups (economic, environmental, and social sustainability) given that the aforementioned amount of variance exceeded 50%, and the weighting factors of all the items in each scale exceeded 0.5 [99].

3.3.2. Cooperation

The model uses information on active cooperation in innovation with external partners. The explanatory variables (C_{dit}) include cooperation for the innovation of company “i” with different partners “d” at the temporary moment “t”. This cooperation consists in the active participation with other companies from the group, providers, clients, competitors, consultants, universities, and research

centers, in activities of innovation. The two parties do not necessarily obtain commercial profit. Simply subcontracting work without active cooperation was excluded [8].

3.3.3. Absorptive Capacity

Given the multidimensional nature of knowledge, we needed to distinguish between two types: one for establishing a company's capacity to assess external information, and a second for assessing its capacity to use it. The first entails relatively simple knowledge while the second implies complex and abstract knowledge [100].

We considered the two aforementioned types of absorptive capacity: the first allows a company to scan their immediate environment for knowledge, for which we used the responses on the importance of external information sources for innovation. These sources, contained within the "information sources" (I_{cit}) variable, include clients, providers, competitors, universities, consultants, commercial laboratories, or private R&D institutes, within a company or group of companies, departments, employees, etc. [101,102].

As a proxy for the second type of absorptive capacity, the (P_{eit}) variables are used, which collect, by quartiles, the percentage of human capital with higher education that the company "i" has at a given moment "t". Having this kind of employee increases a company's ability to absorb and apply new knowledge in their innovation processes. In addition, it facilitates the exchange of knowledge within the organization and offers a greater capacity to find, integrate, and use new tacit knowledge [91,103].

The reason for dividing the human capital with higher education variable into quartiles is that this allowed us to better observe the different knowledge needs that are required by companies to cooperate in innovation with their various partners which, in turn, provide skills and different capacities [74].

Given that human capital, through training and experience, can be improved and, therefore, have a greater capacity to absorb and use new sources of knowledge [71], we postulated that the employees of companies with FDI, being highly qualified [85] and having to develop multicultural skills and interact across borders, will develop a greater absorptive capacity [104], which will give them a greater propensity for SOI.

3.3.4. Moderating Variables

In Model (4), we tried to check the moderator role of the "staff" (P_{eit}) and "cooperation" (C_{dit}) variables in the development of SOI. A moderation hypothesis attempts to determine under what conditions a relationship becomes stronger, weaker, disappears, or changes direction. A moderating variable is a qualitative or quantitative variable that affects the magnitude and/or direction of a relationship between an independent or predictor variable and a dependent variable or criterion. The moderating effects are also called interaction effects.

Moderating variables have been introduced to verify the following hypotheses:

Hypothesis 1 (H1). *Thanks to having qualified human capital, can the assimilation and exploitation of companies' external sources be improved, in such a way that those that have enough will be able to efficiently manage said sources?*

In this paper, this is reflected in the use of these employees in cooperation with different partners. To assess this, we included a product term between the "cooperation" (C_{dit}) and "staff" (P_{eit}) variables, which encompass qualified human capital used as a proxy for the second type of absorptive capacity [102].

Companies face an important challenge in the development of SOI, since sustainability must be understood and integrated into the innovative process [2]. In this context,

Hypothesis 2 (H2). *Can staff training play a key role in guaranteeing the skills for this?*

The assessment for this is carried out through a product term between the variables “indicators of sustainable objectives” and “staff” ($P_{eit} * ISO_{fit}$).

Given that the literature places the emphasis on knowing how companies expand and exploit their external links as regards sustainability through cooperation with external collaborators [3],

Hypothesis 3 (H3). *Can cooperation with each of the potential partners affect the different sustainable areas?*

The paper measures how cooperation with each of the potential partners can affect the different sustainable areas through the product of the “cooperation” variable and the “indicators of sustainable objectives” variable ($C_{dit} * ISO_{fit}$). This, therefore, implies that a diverse range of paths can be taken to achieve this [7].

Learning is key to increasing skills in the area of SOI, understanding it as the assimilation and application of acquired knowledge, so that not only will the participation of external partners be required, which provide new paths and knowledge structures but, also, human capital with some kind of higher education, to assimilate and apply new knowledge in a company’s innovation processes [59,60,91,101]. In this regard,

Hypothesis 4 (H4). *What kind of learning will enhance sustainable objectives?*

Hence, we introduced the product of the variables “cooperation”, “staff”, and “indicators of sustainable objectives” ($C_{dit} * ISO_{fit} * P_{eit}$).

3.3.5. Control Variables

The following control variables were included in this paper. Firstly, we controlled the company “size” (S_{ait}) variable, in which we distinguish between large companies and SMEs [105].

This division is important because, despite as SMEs are recognized as being key for sustainable development, their research tends to focus more on environmental issues than SOI. In addition, these often have a lack of resources, a situation that acts as an incentive for them to cooperate with others. In this sense, there are studies that find an inverse relationship between firm size and a proven commitment to sustainability ideals [106].

However, few studies explore the role that the different partners play in contributing knowledge for achieving SOI [61]. Studying the strategies of these businesses can provide a better understanding of the tensions between firm size and sustainability goals [107].

For its part, there is ample evidence to indicate that large companies increase opportunities for innovation, as they have more extensive resource bases [4] and have the internal capacities needed to participate in R&D alliances [103].

Secondly, we controlled “age” (A_{bit}), which, like “size”, is widely used as a control variable in studies of this nature. The company’s age can have an influence, given that having more experience probably means a greater accumulation of knowledge, but can also become a source for generating inertia, which enables adaptation, as well as the introduction of new developments in products and processes [108]. It seems that older companies are better, or that they currently place more emphasis on the integration of sustainability issues [2].

4. Result

Table 4 (for more information, see Appendix C) shows the results obtained from the binary logistic regression for the two compared groups, FDI vs NFDI, considering their size, thereby allowing us to carry out a comparative analysis and study the shared and disparate effects which result from this. Four possible scenarios of how companies can achieve SOI were found (for the comparison between variables, we need to look at the difference in the odds ratio. The odds of the event is the probability

it will occur divided by the probability that it will not. It is, therefore, interpreted as a ratio, i.e., the number of times that something could happen over the times it might not happen).

Table 4. Results of the logistic regression.

Independent Variable	SMEs NFDI		SMEs FDI		BIG NFDI		BIG FDI	
	β	Odds Ratio	β	Odds Ratio	β	Odds Ratio	β	Odds Ratio
Constant	0.56	0.57	−0.71	0.49	−0.2	0.82	−0.29	0.75
Control variables								
S ₂	0.34 ***	1.4	0.86 ***	2.35				
S ₃	0.57 ***	1.77	0.31 ***	1.37				
S ₄					−0.42 ***	0.66	−0.41 ***	0.66
Indicators of Sustainable Objectives								
ISO ₁	0.47 ***	1.6	0.38 ***	1.47	0.47 ***	1.59	0.39 ***	1.48
ISO ₂	0.14 ***	1.15	0.21 ***	1.23	0.14 ***	1.15	0.18 ***	1.2
ISO ₃	0.09 ***	1.1	0.15 **	1.16	0.09 ***	1.09	0.15 **	1.16
Cooperation								
C ₄	0.67 ***	1.96	1.12 ***	3.08	0.67 ***	1.95	1.2 ***	3.32
C ₅	0.27 ***	1.31			0.28 ***	1.32		
C ₆	0.64 ***	1.89	1.64 ***	5.16	0.64 ***	1.9	1.64 ***	5.14
Absorptive capacity								
I ₁	1.1 ***	3.01	0.82 ***	2.28	1.11 ***	3.05	0.80 ***	2.24
I ₂	−0.35 ***	0.7			−0.33 ***	0.72		
I ₃	0.46 ***	1.58	0.27 ***	1.31	0.45 ***	1.57	0.28 ***	1.33
I ₆	0.57 ***	1.76	1.01 ***	2.73	0.58 ***	1.78	1.004 ***	2.73
P ₁	−0.37 ***	0.69			−0.3 ***	0.74		
P ₂	0.1 ***	1.1	0.19 **	1.21	0.11 ***	1.12	0.21 **	1.23
P ₃			0.33 **	1.38			0.29 **	1.34
P ₄	0.25 ***	1.28	−0.47 ***	0.62	0.19 ***	1.2	−0.44 ***	0.64
Moderating variables								
C ₁ *P ₁							0.25 **	1.28
C ₁ *P ₂			0.61 ***	1.84			0.61 ***	1.83
C ₁ *P ₃			−0.53 **	0.59			−0.52 **	0.59
C ₃ *P ₃			−0.96 **	0.38			−1.06 ***	0.34
C ₆ *P ₁			−1.23 ***	0.29			−1.19 ***	0.3
C ₆ *P ₂							−0.93 **	0.4
C ₆ *P ₃			2.01 **	7.47			2.33 **	10.24
C ₂ *ISO ₂			0.54 ***	1.72			0.50 ***	1.65
C ₃ *ISO ₂	−0.22 ***	0.8	−0.38 **	0.68	−0.21 ***	0.81		
C ₆ *ISO ₁			0.81 ***	2.25			0.79 ***	2.21
C ₆ *ISO ₃			−0.66 ***	0.51			−0.58 **	0.56
P ₁ *ISO ₃			0.22 ***	1.25			0.23 ***	1.26
P ₄ *ISO ₃			−0.37 ***	0.69			−0.39 ***	0.68
C ₂ *P ₂ *ISO ₃			−0.86 ***	0.42			−0.86 ***	0.42
C ₂ *P ₃ *ISO ₃			0.63 **	1.87				
C ₅ *P ₁ *ISO ₂	0.34 ***	1.41			0.35 ***	1.42		
C ₅ *P ₂ *ISO ₂	−0.41 **	0.66			−0.41 **	0.66		
C ₅ *P ₄ *ISO ₂							1.02 **	2.77
C ₅ *P ₁ *ISO ₃	−0.26 **	0.77			−0.27 **	0.76		
C ₅ *P ₃ *ISO ₃	−0.42 **	0.66			−0.39 **	0.68		

Table 4. Cont.

Independent Variable	SMEs NFDI		SMEs FDI		BIG NFDI		BIG FDI	
	β	Odds Ratio	β	Odds Ratio	β	Odds Ratio	β	Odds Ratio
$R + D + i_{it}$								
$C_6 * P_2 * ISO_2$			1.09 **	2.98			1.32 ***	3.73
Number of cases	28,536		5646		28,536		5646	
Omnibus test	6005.662 (23)	0.0E0	1576.629 (37)	1.4647E-307	5925.798 (21)	0.0E0	1561.328 (35)	2.5953E-304
Nagelkerke's R ²	0.334		0.424		0.330		0.420	
Hosmer–Lemeshow test	39.069 (8)	0.0512	46.328 (8)	0.0549	42.506 (8)	0.0533	28.804 (8)	0.0656
Percentage of correct predictions:	71.3		76.9		71.4		76.4	

Source: prepared by the authors. Note: ** and *** significant coefficients up to 5% and 1%, respectively.

Analyzing the results, we can see that, across the board, there is a series of direct and indirect relationships when it comes to incentivizing innovation, which is oriented towards sustainability through its goals. These relationships for SMEs with FDI are represented in Figure 1.

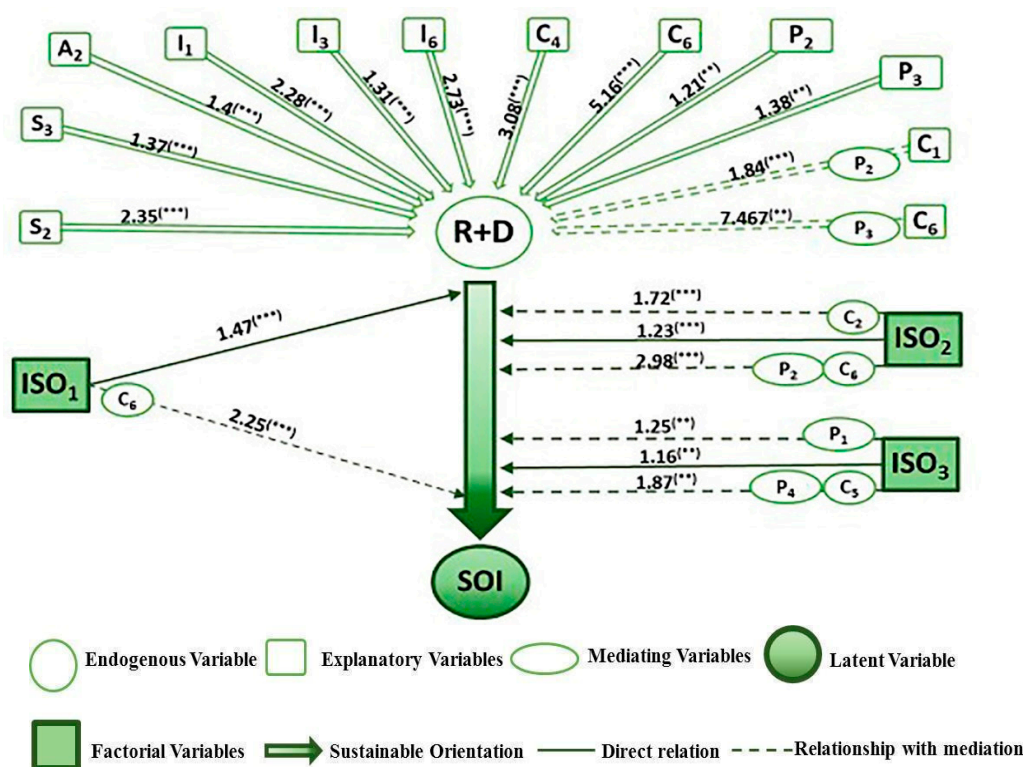


Figure 1. Orientation towards sustainability for SMEs with foreign direct investment (FDI). Source: prepared by the authors. Note: the value represents the odds ratio. (**), (***) significant coefficients up to 5% and 1%.

Figure 1 shows that, although being of a medium-size, Company (S₃) increases the possibilities for innovation, and this grows by 98% when it has a size corresponding to between 10 and 50 employees (S₂) (difference between odds ratio S₂ and odds ratio S₃), this being influenced by companies aged between 5 and 15 years old (A₂), as the other (A_{bit}) variables are not significant.

These SMEs will be more innovative if they have information which is from universities (I₆), internal (I₁), and from the client (I₃), this being the order based on their odds ratios (2.73 > 2.28 >

1.31). With regard to the integration of stakeholders, we can observe how the cooperation (C_6) with competitors and universities (C_4) increases innovation.

The significance of the products ($C_6 \cdot P_3$) and ($C_1 \cdot P_2$) suggests that there is better assimilation and exploitation both of cooperation with universities (C_6) and internal cooperation (C_1), thanks to qualified staff. This improvement is more than double for the case of universities, but requires between 50% and 75% qualified staff (P_3). If there is 25–50%, qualified staff (P_2), there will be an improvement due to internal cooperation, which will increase the possibilities of innovation by 84%.

SMEs that orient their innovation goals towards sustainability have a greater propensity to innovate, demonstrated by the significance of all the goals (ISO_1, ISO_2, ISO_3). However, we do see that the influence of these goals on the innovative process, aside from being direct, can be moderate.

The moderator effect of cooperation with universities ($C_6 \cdot ISO_1$) and providers ($C_2 \cdot ISO_2$) indicates that these links will enhance the effect of economic and environmental sustainability, specifically increasing innovation by 78% and 49%, respectively.

The moderator effect of staff ($P_1 \cdot ISO_3$) establishes that with less than 25% qualified staff, there will be sufficient skills to understand and efficiently integrate social sustainability, increasing innovation by 9%.

Lastly, moderation as a whole, between cooperation with universities and qualified staff ($C_6 \cdot P_2 \cdot ISO_2$), reflects the fact that university participation can improve the effect of environmental sustainability, but requires between 25% and 50% qualified staff, which will enable the newly acquired knowledge to be applied to innovation, increasing this by 175%. Equally, cooperation with consultants and qualified staff ($C_5 \cdot P_4 \cdot ISO_3$) reflects the fact that the participation of these can improve the effect of social sustainability, but requires more than 75% qualified staff, which allows newly acquired knowledge to be applied to innovation, increasing this by 71%.

Figure 2 compares these results with those corresponding to NFDI SMEs.

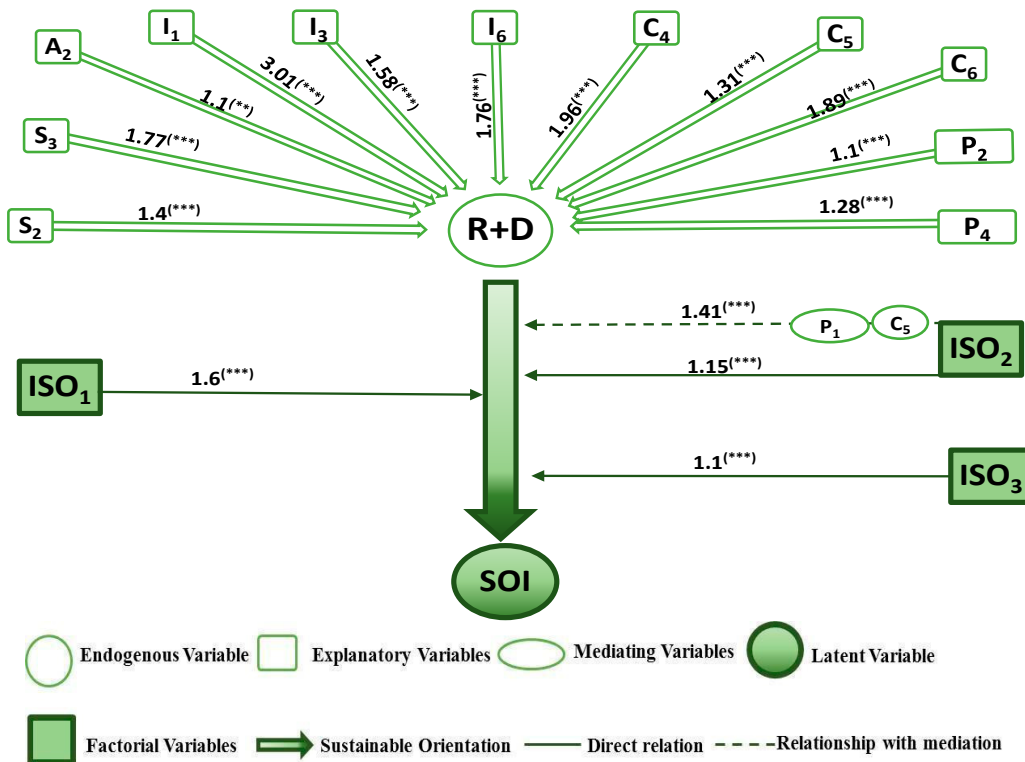


Figure 2. Orientation towards sustainability for SMEs without foreign direct investment (NFDI). Source: prepared by the authors. Note: the value represents the odds ratio. (**), (***) significant coefficients up to 5% and 1%.

The first difference we can observe is that which relates to size. In contrast to the previous case, although being a small company (S_2) increases the possibilities of innovation, these increase by 37% when the company employs between 50 and 250 workers (S_3) (difference between odds ratio S_3 and odds ratio S_2). There is a shared trait, however, in that both are influenced by age, within the 5-to-15-year range (A_2), as the rest of the (A_{bit}) variables are not significant.

These SMEs, like their counterparts, will be more innovative if they have information that is internal (I_1), and from universities (I_6) and clients (I_3), however, the order has been modified, with an emphasis placed on the importance of information derived from companies of the group, department, etc. As regards the integration of stakeholders, we can observe how cooperation with competitors (C_4) and universities (C_6) increases innovations as it did with the previous SMEs, and there is now cooperation with consultants (C_5).

However, despite there being a direct influence of the absorptive capacity on two ranges, one from 25–50% (P_2) and the other from 75–100% (P_4), there is no moderator effect with cooperation that motivates innovation.

In this scenario, the NFDI SMEs that orient the goals of their innovation towards sustainability are more inclined to innovate, as indicated by the significance of all the goals (ISO_1, ISO_2, ISO_3), as happened in the previous case. The difference can be seen in the effect of these goals, which is direct, and is only strengthened indirectly in the case of environmental sustainability goals (ISO_2).

Moderation as a whole, therefore, between cooperation with consultants and staff ($C_5 * P_1 * ISO_2$) reflects the idea that participation of this nature can lead to improvements in the effect of environmental sustainability, but this requires less than 25% qualified staff, which will enable newly acquired knowledge to be applied to innovation, increasing this by 26%.

The results for the large companies in both groups do not differ to those of the SMEs, except in the probability of certain relationships, as can be seen below, Figure 3.

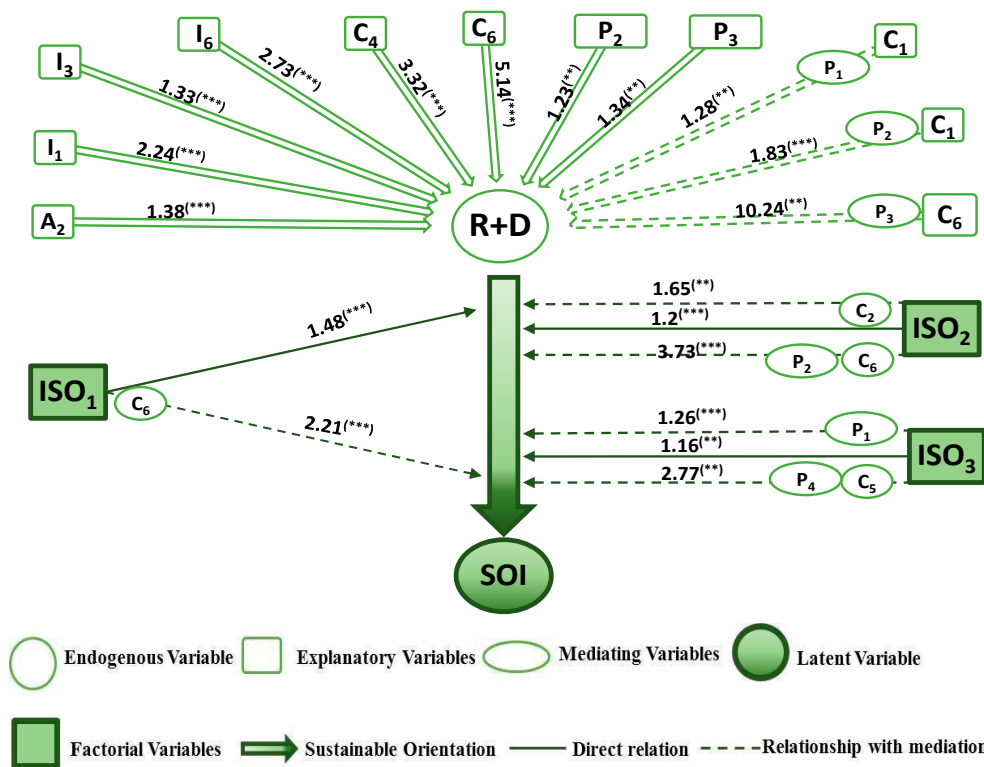


Figure 3. Orientation towards sustainability of large companies with foreign direct investment (FDI). Source: prepared by the authors. Note: the value represents the odds ratio. (**), (***) significant coefficients up to 5% and 1%.

What can be seen first, in Figure 3, is that there is no S_4 variable, because, as can be observed in Table 4, this variable is significant but negative, indicating that, within this group, the companies with the fewest employees are the most innovative. On the other hand, as in the two previous cases, innovation continues to be influenced by the age of those between 5 and 15 years (A_2), since the rest of the (A_{bit}) variables are not significant.

These large companies are more innovative if they have information which is from universities (I_6), internal (I_1), and from the client (I_3), this being the order based on their odds ratios ($2.73 > 2.24 > 1.33$). With regard to the integration of stakeholders, we can see how cooperation with competitors (C_4) and universities (C_6) increases innovation.

The significance of the products ($C_6 * P_3$), ($C_1 * P_1$), and ($C_1 * P_2$), indicates that there is better assimilation and exploitation of both cooperation with universities (C_6) and internal (C_1), thanks to qualified staff. This improvement will more than double in the case of university cooperation, but requires between 50% and 75% of qualified staff (P_3). On the other hand, there will be an improvement due to internal cooperation that will increase the possibilities of innovation by 28%, if qualified staff is less than 25% (P_1), and of 83% if qualified staff amounts to more than 25% and less 50%.

Large companies that orient their innovation goals towards sustainability have a greater tendency to innovate, which can be seen in the significance of all their goals (ISO_1 , ISO_2 , ISO_3). However, we do see that the influence of these goals on the innovative process, aside from being direct, can be moderate.

The moderator effect of cooperation with universities ($C_6 * ISO_1$) and providers ($C_2 * ISO_2$), indicates that these links will enhance the effect of economic and environmental sustainability, specifically increasing innovation by 73% and 45%, respectively.

The moderator effect of staff ($P_1 * ISO_3$), establishes that with less than 25% qualified staff, there will be sufficient skills to understand and efficiently integrate social sustainability, increasing innovation by 10%.

Lastly, moderation as a whole, between cooperation with universities and qualified staff ($C_6 * P_2 * ISO_2$), reflects the fact that participation of universities can improve the effect of environmental sustainability, but requires between 25–50% qualified staff, which will enable the newly acquired knowledge to be applied to innovation, increasing this by 253%. Equally, cooperation with consultants and qualified staff ($C_5 * P_4 * ISO_3$) reflects the fact that the participation of these can improve the effect of social sustainability, but requires more than 75% qualified staff, which allows newly acquired knowledge to be applied to innovation, increasing this by 161%.

As can be seen, there are behavioral patterns common to companies with FDI, regardless of size. To see if this differs from large companies without foreign participation, we analyzed Figure 4 and compared it with Figure 3.

What is made evident first when looking at this diagram is that there are no differences in terms of the variable S_4 , since, as can be seen in Table 4, this variable is significant, but negative, in both cases. On the other hand, unlike in the previous cases, innovation is not influenced by the age of the company because (A_{bit}) is not significant.

The second difference that can be observed is the order of importance of the sources of information, as these companies will be more innovative if they have information that is internal (I_1), from universities (I_6), and from the client (I_3), in this order, in accordance with their odds ratios. Information coming from companies of the group, or company departments, etc., stands out here. With regard to the integration of stakeholders, we can see how cooperation with competitors (C_4) and universities (C_6) increases innovations in the same way as it does for large companies with FDI, and there is now cooperation with consultants (C_5).

However, despite there being a direct influence of the absorptive capacity on two ranges, one from 25–50% (P_2) and the other from 75–100% (P_4), there is no moderator effect with cooperation that motivates innovation.

In this scenario, the NFDI SMEs that orient the goals of their innovation towards sustainability are more inclined to innovate, as indicated by the significance of all the goals (ISO_1 , ISO_2 , ISO_3), as

happened in the previous case. The difference can be seen in the effect of these goals, which is direct, and is only strengthened indirectly in the case of environmental sustainability goals (ISO₂).

Moderation as a whole, therefore, between cooperation with consultants and staff (C₅*P₁*ISO₂), reflects the idea that participation of this can lead to improvements in the effect of environmental sustainability, but this requires less than 25% qualified staff, which will enable newly acquired knowledge to be applied to innovation, increasing this by 27%.

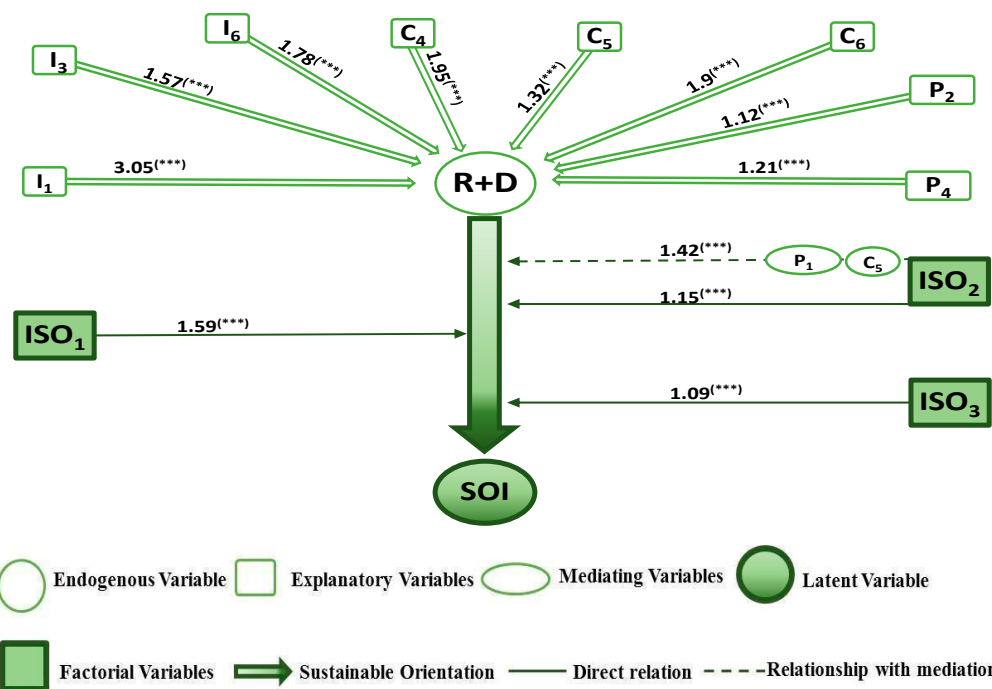


Figure 4. Orientation towards sustainability of large companies without foreign direct investment (NFDI). Source: prepared by the authors. Note: the value represents the odds ratio. (**), (***) significant coefficients up to 5% and 1%.

5. Discussion

This study proposed researching the different channels for accessing knowledge for SOI, examining them through absorptive capacity and cooperation, according to company age and size, in a comparative analysis between foreign and national companies.

The literature establishes, on the one hand, that the complexity of SOI implies the inclusion of a wide set of actors and, on the other, that FDI enables its requirements to be met [7,17]. This comparative study arises from these two premises, based on which we have found that such diversity gives rise to two paths by which sustainable goals influence the innovative process, one direct and the other moderate.

In reference to the former, and in line with the literature that establishes that innovation can be driven by sustainability [1,16], these results go one step further by responding to the request for greater direct monitoring of the impacts of sustainability [64]. The results show that, for both types of company, economic sustainability has the most weight in innovation, followed by environmental sustainability, with social sustainability having the least weight of the three.

However, if we consider this shared trait, we see that the importance of innovation for these goals of environmental and social sustainability is greater in companies with FDI than in companies without FDI, the opposite being the case with goals of economic sustainability.

As regards the latter, the moderator effect (Table 5), and the literature establishes that:

- To understand and integrate sustainability in the innovative process requires having qualified staff with the skills to do so [2]. This only happens if the company has FDI, less than 25% qualified

- staff, and if innovation has been oriented by social sustainability, indicating that these companies require the second type of absorptive capacity [100].
- Cooperation with external partners in the interest of sustainability should be exploited [3]. Companies with FDI will achieve this exploitation when they cooperate with universities and providers, improving their economic and environmental sustainability, respectively. The role of providers, as key partners for environmental sustainability, corroborates the idea of the presence of technological interdependencies [8].
 - To achieve sustainability, learning is key, when understood as the assimilation and application of newly acquired knowledge in SOI [59,60], in both types of company. For those that have FDI, learning from universities can enhance environmental sustainability and learning from consultants can enhance social sustainability, the latter requiring a greater percentage of qualified staff. For companies without FDI there is learning from consultants, which enhances environmental sustainability, without a significantly high percentage of qualified staff. These results run counter to studies that establish that the level of education of workers does not affect the introduction of environmental innovation [62], and demonstrate that the management of knowledge and cooperation are drivers of sustainable innovation [64].

Table 5. Comparison of the moderator effect between companies with foreign direct investment (FDI) vs without foreign direct investment (NFDI).

Innovative Companies with Foreign Direct Investment (FDI)	Innovative Companies without Foreign Direct Investment (NFDI)
Economic sustainability through cooperation with universities	
Environmental sustainability through university-based learning and cooperation with the provider	Environmental sustainability through learning from consultants, thanks to qualified workforce not exceeding 25%
Social sustainability through human capital, generating learning from consultants if this is very high	

Source: prepared by the authors.

Successful sustainable innovation needs a focus on resource co-specialization that allows companies to bring together specialized resources and competences scattered in diverse actors around a sustainability opportunity [69].

Therefore, a greater propensity to innovate sustainably, thanks to external knowledge sources and cooperation agreements [61], only occurs for the case of cooperation with providers, universities, and consultants. This runs counter to the idea that a more proactive and structured relationship with clients can foster the acquisition of sustainability-oriented knowledge [63]. This result is not surprising given the complexity attached to these innovations.

Greater use of relationships with universities in the case of environmental sustainability indicates, on the one hand, an interdependence between knowledge, skills, and resources, which arise in the development of said innovations and, on the other, a need to complement the knowledge base [62].

The results of this comparative analysis align with the literature, which distinguishes the cooperation models of foreign and national companies [25,88] and, more specifically, with those studies that establish that companies with FDI have a greater propensity to cooperate in R&D [26,87].

However, the results run counter to the idea that this distinction, when related with aspects of sustainability, is motivated by knowledge complementarity [25], as they show that foreign companies are more likely to innovate if they cooperate with universities and providers. In addition, they are contrary to the technology orientation negatively affecting environmental dimensions [30].

Finally, the positive impacts of big companies (FDI and NFDI) whose innovation is oriented by sustainable objectives, is similar to that of SMEs (FDI and NFDI). This is contrary to the literature,

which establishes an inverse relationship between firm size and a proven commitment to sustainability ideals [106].

6. Conclusions

The SOI cases in this study display the distinctive traits of sustainable innovation for companies with and without FDI, in terms of the capacities required for integrating external actors and their effects. It also provides a deeper understanding of the different channels for accessing knowledge for SOI, as it examines the links through absorptive capacity and cooperation, according to company age and size. It thereby contributes to the literature that analyzes the benefits of cooperation.

This paper jointly considered the effects of firm strategic and organizational orientations (technology orientation and internally organizational orientation) on several dimensions of sustainable performance, objectively measured, and contributes to advancing the existing knowledge on the relationships between firms' orientations and their sustainable performance.

It provides a useful theoretical lens for advancing knowledge of management practices for sustainable innovation. In addition, this leads to improving practical understanding of how resources and competences are deployed, and firms, through innovation, create sustainability value. This shows that a company's innovation for sustainability notably depends on how effectively the company catches the complementary resources and competences around an innovation opportunity.

One of the most significant implications arises from not having an integrated absorptive capacity in a construct, thereby offering the possibility of seeing the individual effect of each dimension. Therefore, if a company wants to maximize the effect of cooperation with its partners, it should consider that qualified staff is not the same in all cases, and depends on the type of cooperator and the goal of the cooperation. This document sheds light on the possibilities of improving the absorptive capacity for acquiring and assimilating knowledge on issues related to sustainability.

This study contributes to the international literature by looking, in greater depth, at the comparative differences in behavior of foreign and national companies, analyzing how the same elements affect their interaction and result in sustainable development. Focusing on companies with FDI highlights the specific and intrinsic advantages associated with foreign investment, and how those companies gain knowledge when interacting with diverse markets and institutional sources. This shows how external links make these companies more innovative, as well as more sustainable.

This study concludes that similar efforts to orient innovation towards sustainable goals should be more skeptical with respect to approaches that rely primarily on size differentiation. However, the fact that sustainability-oriented knowledge is acquired and assimilated more efficiently in SMEs with FDI, shows that FDI helps companies to meet the requirements demanded by SOI by offering the internal capacities and cooperation structure to facilitate this.

Given the complexity of SOI, companies with FDI cooperate with universities and private research institutes, which provide highly specialized knowledge, and with providers, because of their understanding regarding the supply of raw materials and inputs that help to reduce resource intensity, emissions, and waste, proof of their capacity to import specialized knowledge.

In this process, the absorptive capacity serves as a moderator, strengthening the effect of environmental and social goals in the innovative process, becoming a core competency for IOS. Staff will, therefore, be sufficiently qualified and have the necessary characteristics to retain, reactivate, and apply the knowledge obtained in products and processes, confirming a company's potential to achieve sustainable innovations.

Therefore, FDI helps overcome the difficulty of creating learning networks derived from an SOI process. It is different in how it cooperates and obtains external knowledge, preferring not to look only for local knowledge, but also specialized knowledge. This is different from what the literature establishes as its habitual behavior when undertaking unsustainable innovations, without this difference growing due to size and age.

From a general perspective, a question that companies involved in sustainable initiatives should address is how to reconcile cooperation with different partners. This study helps managers to get involved in sustainable development by offering some initial guidelines that will enable them to benefit from cooperation with different partners, and the possible effects of this on their companies' capacity for sustainable innovation. These guidelines will enable companies to understand how, based on their needs, they should complement their knowledge to achieve SOI. Thus, the companies' managers should think of alternative, sustainably innovative routes to go, and adopt different approaches for managing innovation for sustainability.

Limitations and Future Research

There are certain limitations to this study that offer new research opportunities. First, the findings of this research are based on a quantitative study. Future research should also include case studies that take into account other actors, such as NGOs, for example, expanding the scope of this issue.

Second, we created our own measures for strategy by collecting data in the Technological Innovation Panel (PITEC). Although this could seem to provide measures that are highly dependent on what companies want to communicate to stakeholders, it is coherent with our aim of measuring "orientation" [30].

Third, training employees enables companies to recognize and acquire external knowledge, although there are studies that establish that infrastructure capacities could also be enhanced [63]. Future research, therefore, could include these within an absorptive capacity.

Fourth, by taking into account the goals that orient innovation, we controlled the relevance of the different partners arising from the specific strategy pursued by the company. However, the relevant partners can also vary depending on the industry, something which should be contemplated in future studies [62].

Fifth, although this study offers a detailed vision of cooperation with diverse partners individually, neither frequency nor depth were included, both of which are concepts that would enable cooperation networks for sustainable innovation to become operational [71].

Sixth, it should be considered that cooperation in companies with FDI could be influenced both by its origin and by how it entered the company, both of which are aspects that could potentially influence a company's motivation for seeking to complement its knowledge [25].

Seventh, an in-line analysis with a Bayesian approach using a posterior odds ratio approach would be interesting.

Lastly, given that the interaction between universities and companies with FDI can represent a powerful mechanism for improving the linkage between national innovation systems and global innovation dynamics, it would be interesting to study the incentives for the financing that would enhance this interaction [88].

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Appendix A. Variables of the Model

- Dependent or explained variable:
 - $R + D + i_{it}$ Company "i" undertakes or does not undertake internal innovation activity at the point in time "t". This variable arises from the question:
 - Has your company undertaken internal R&D activities in the year t?

- Independent or explanatory variables:
 - **Company size (S_{ait}):** Takes a value of 1 if the company “i” has a size “a” at the point in time “t” and a value of 0 if not. Where a = 1 if it is a Micro-enterprise, a = 2 if it is a Small Company, a = 3 if it is a Medium Company and a = 4 for Large Companies (a Micro-enterprise is considered any company with fewer than 10 employees, Small Company with between 10 and 50 employees, Medium Company between 50 and 250 and Large Companies if it has more than 250 employees [105]).
 - **Company Age (A_{bit}):** Takes a value of 1 if the company “i” has an age “b” at the point in time “t” and a value of 0 if not. Where b = 1 if it is less than 5 years old, b = 2 if it is between 5 and 15 years old and b = 3 if it is more than 15 years old (given that SMEs generally have a high mortality rate in the first five years, there is the generalized idea that this is an incubation period, which needs to be exceeded for the company to become fully established [109]).
 - **Information source (I_{cit}):** Variable that includes the importance of each of the sources “c” for the innovation activities of company “i” at the point in time “t” (initially this variable was scored on a scale of one to four depending on the level of importance (1 = High, 2 = Medium, 3 = Low and 4 = Not relevant). To facilitate the handling and interpretation of the variables, the scale was restructured so that the values 1 and 2 take a value of 1, while the values 3 and 4 take a value of 0). This variable arises from the question:
 - In the period t – 2 to t, what importance have each of the following information sources had for the innovation activities of your company?
 - c = 1: Internal information (within the company or group of companies, departments, employees ...).
 - c = 2: Providers of equipment, material, components or software.
 - c = 3: Clients.
 - c = 4: Competitors or other companies from its branch of activity.
 - c = 5: Consultants, commercial laboratories, or private R&D institutes.
 - c = 6: Universities or other higher education centers.
 - **Cooperation (C_{dit}):** Variable used if for the innovation activities of company “i” the company has cooperated with partner “d” at the point in time “t”. It takes a value of 1 if it has cooperated and 0 if not. This variable arises from the question:
 - In the period t – 2 to t, did your company cooperate with other companies or entities in any of its innovation activities? Indicate what kinds of partners were involved:
 - d = 1: Other companies from its own group.
 - d = 2: Providers of equipment, material, components or software.
 - d = 3: Clients from the private and/or public sector.
 - d = 4: Competitors or other companies from its branch of activity.
 - d = 5: Consultants or commercial laboratories
 - d = 6: Universities or other higher education centers.
 - **Personal (P_{eit}):** Variable that represents the percentage of human capital with higher education, “e”, of company “i” at the point in time “t”. It takes a value of 1 if the company has this human capital and 0 if it does not. In the model that we propose, this variable is split into quartiles:
 - e = 1: If the company has between 0% and 25% of staff with higher education.
 - e = 2: If the company has between 25% and 50% of staff with higher education.
 - e = 3: If the company has between 50% and 75% of staff with higher education.

- e = 4: If the company has between 75% and 100% of staff with higher education.
- **Indicators of Sustainable Objectives (ISO_{fit}):** Variable that includes the goal “f” that has oriented the innovation of the company “i” at the time “t”. Where f = 1 for the economic sustainable objective indicator, f = 2 for the environmental sustainable objective indicator and f = 3 for the social sustainable objective indicator (these three variables are the sustainable objective indicators and have been constructed through an analysis of the main components). This variable arises from the question:
 - In the period t – 2 to t, the innovative activity undertaken in your company may have been oriented towards different objectives. Indicate the degree of importance of the objectives (this variable was scored on a scale of one to four depending on the level of importance (1 = High, 2 = Medium, 3 = Low and 4 = Not relevant)).

Appendix B. Indicators of Sustainable Objectives

As can be seen in Table A1, the results show that the goals oriented towards economic sustainability represent 63.48% and 63.11% of the variance, for the FDI and NFDI groups, respectively (statistic K-M-O 0.754 and 0.753, average ratio), the goals oriented towards environmental sustainability represent 72.89% and 71.06% of variance (statistic K-M-O 0.708 in both cases, average ratio) and, lastly, the goals oriented towards social sustainability represent 64.02% and 62.49% of the variance (statistic K-M-O 0.800 in both cases, satisfactory ratio). The alpha coefficients have an acceptable value that ranges from 0.796 to 0.875 for companies with FDI and from 0.793 to 0.863 for NFDI companies, values that are far higher than the recommended value of 0.7, which is considered satisfactory for exploratory research [97].

Therefore, a model with these factors is suitable for assessing the sustainability of the innovative process. The first factor, the “**Economic sustainable objective indicator**”, shows the variables that have a shared underlying economic dimension. The main variables, which have a strong influence on this factor, are those related with new markets and a greater capacity to produce and, therefore, having a wider range to sell, which shows a relationship with innovative solutions in economic sustainability. The second factor, known as the “**Environmental sustainable objective indicator**”, includes the variables related with the environment, which means that these goals foster innovations related with environmental sustainability. Lastly, the “**Social sustainable objective indicator**” includes variables with a dual social impact: on the one hand, if it improves the quality of the products that clients receive and, on the other, if it improves quality of life, individual wealth, new jobs are created, or there is greater security for the worker.

Table A1. Validity and reliability results for the scale of the items of the factorial analysis of the main components of the Indicators of Sustainable Objectives.

Factor	Items	Factor Structure Matrix		Explained Variance	
		FDI	NFDI	FDI	NFDI
Economic sustainable objective indicator	Wider range of goods or services	0.832	0.818	63.94%	63.15%
	Penetration in new markets	0.879	0.884		
	Higher market share	0.904	0.893		
	Increased production or service capacity	0.526	0.528		
	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.755	0.753		
	Cronbach's Alpha	0.800	0.793		
Environmental sustainable objective indicator	Less material per unit produced	0.831	0.833	71.95%	71.06%
	Less energy per unit produced	0.883	0.865		
	Lower environmental impact	0.858	0.846		
	Compliance with environmental regulatory requirements	0.820	0.828		
	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.709	0.708		
	Cronbach's Alpha	0.869	0.863		

Table A1. Cont.

Factor	Items	Factor Structure Matrix		Explained Variance	
		FDI	NFDI	FDI	NFDI
Social sustainable objective indicator	Higher quality of goods or services	0.642	0.617	65.2%	62.46%
	Improvement in the health and safety of employees	0.753	0.706		
	Increase in total employment	0.877	0.871		
	Increase in skilled employment	0.895	0.889		
	Job maintenance	0.843	0.834		
	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.808	0.800		
	Cronbach's Alpha	0.857	0.84		

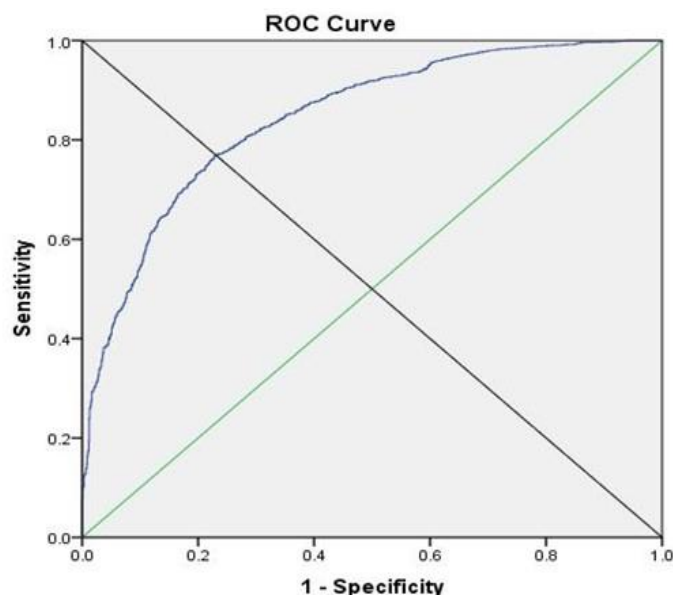
Source: prepared by the authors.

Appendix C. Choice a Cut-Off Value for the Odds

Table A2. Curve OC FDI SMEs.

Area Under the Curve				
Test Result Variable(s): Predicted Probability				
Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.844	0.006	0.000	0.832	0.855
Classification Table ^c				
		Predicted		Percentage Correct
		R + D + i		
Observed		0	1	
R + D + i	0	1063	323	76.7
	1	691	2308	77.0
Overall Percentage				76.9

Source: prepared by the authors. The test result variable(s): Predicted probability has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased. ^(a) Under the nonparametric assumption; ^(b) Null hypothesis: true area = 0.5, ^(c) The cut value is 0.675.



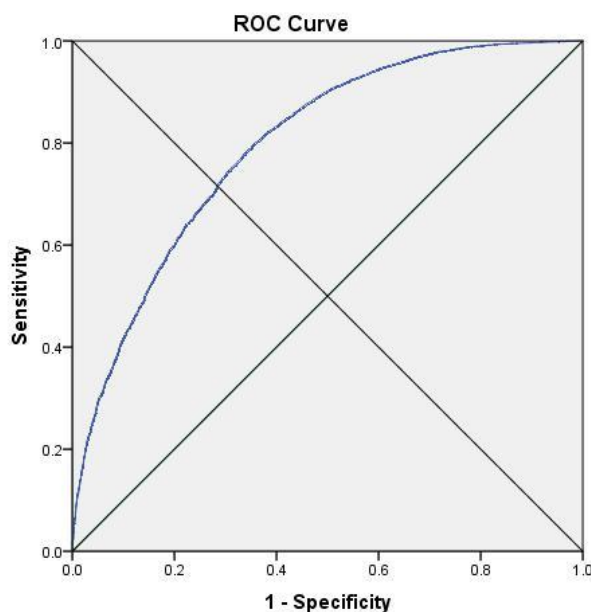
Diagonal segments are produced by ties.

Figure A1. Curve ROC FDI SMEs.

Table A3. Curve ROC NFDI SMEs.

Area Under the Curve				
Test Result Variable(s): Predicted Probability				
Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.796	0.003	0.000	0.789	0.802
Classification Table ^c				
Observed	Predicted			Percentage Correct
	R + D + i			
0	0	1		
R + D + i	0	4944	1959	71.6
	1	4410	10,873	71.1
Overall Percentage				71.3

Source: prepared by the authors. The test result variable(s): Predicted probability has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased. ^(a) Under the nonparametric assumption; ^(b) Null hypothesis: true area = 0.5; ^(c) The cut value is 0.715.



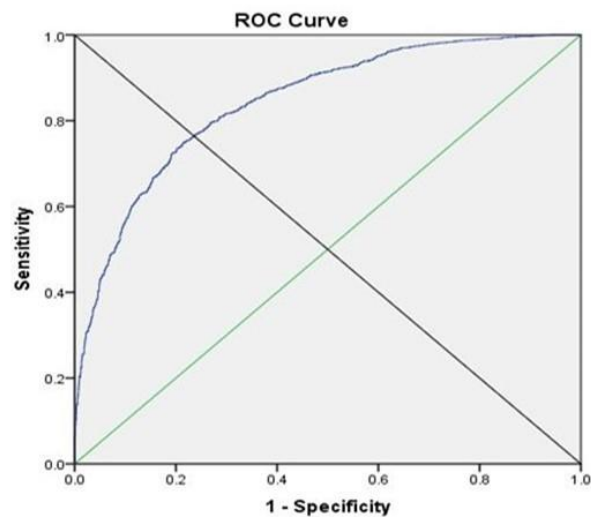
Diagonal segments are produced by ties.

Figure A2. Curve ROC NFDI SMEs.

Table A4. Curve ROC FDI Big.

Area Under the Curve				
Test Result Variable(s): Predicted Probability				
Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.843	0.006	0.000	0.831	0.855
Classification Table ^c				
Observed	Predicted			Percentage Correct
	R + D + i			
0	0	1		
R + D + i	0	1064	322	76.8
	1	715	2284	76.2
Overall Percentage				76.4

Source: prepared by the authors. The test result variable(s): Predicted probability has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased. ^(a) Under the nonparametric assumption; ^(b) Null hypothesis: true area = 0.5; ^(c) The cut value is 0.675.



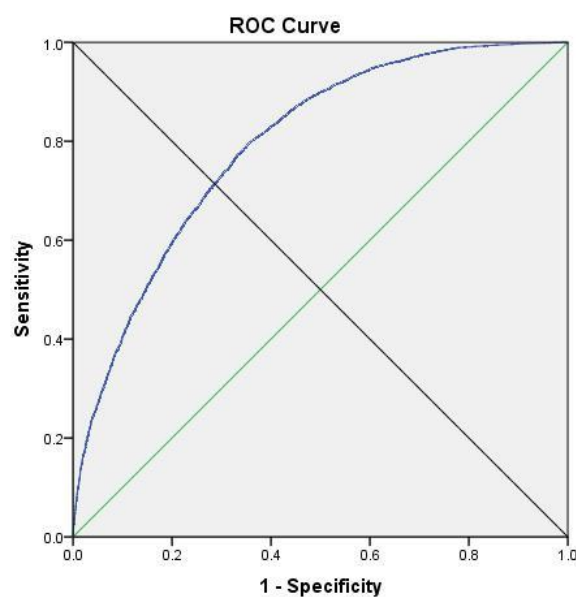
Diagonal segments are produced by ties.

Figure A3. Curve ROC FDI Big.

Table A5. Curve ROC NFDI Big.

Area Under the Curve				
Test Result Variable(s): Predicted Probability				
Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.793	0.003	0.000	0.787	0.800
Classification Table ^c				
Observed	Predicted			Percentage Correct
	R + D + i			
	0	1		
R + D + i	0	4919	1984	71.3
	1	4354	10,929	71.5
Overall Percentage				71.4

Source: prepared by the authors. The test result variable(s): Predicted probability has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased. ^(a) Under the nonparametric assumption; ^(b) Null hypothesis: true area = 0.5; ^(c) The cut value is 0.715.



Diagonal segments are produced by ties.

Figure A4. Curve ROC NFDI Big.

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