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INVESTMENT ATTRACTION IN DEEP TECH STARTUPS: THE EFFECT OF SUSTAINABILITY

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Abstract

Objective: This study aims to understand the resources that explain the attraction of investment in deep tech startups and investigate the role of sustainability as a factor in investment attraction.
Methodology/Approach: Using primary data, logistic regression analysis was applied to a sample of 220 deep tech startups located in the state of São Paulo, Brazil.
Originality/Relevance: The involvement of deep tech startups is crucial in addressing sustainability challenges, yet the extent to which this factor explains investment in startups remains uncertain. Drawing on the Resource-Based View (RBV), this research contributes to the literature by elucidating the resources that drive investments from different stakeholder groups, including partners, government, and third-party investors in deep tech startups.
Main Findings: Third-party private investors are attracted to startups that possess unique resources in the market. The investment by partners is driven by proprietary technology, while government investment is influenced by the superior performance of the startup. However, no association between sustainability and investment attraction was observed.
Theoretical/Methodological Contributions: This study provides insights into the literature on investments and resources by specifically examining how different resources guide investment decisions. Furthermore, it makes a critical contribution by highlighting the absence of a relationship between investments and sustainability.
Social/Managerial Contributions: For entrepreneurs of deep tech startups, this study underscores the importance of valuing and emphasizing different resources based on the intended type of investment, whether from partners, third-party investors, or the government. For investors in deep tech startups, it emphasizes the significance of actively directing investments toward businesses that aim to address socio-environmental issues.

Keywords: Sustainability; Differentiated Resources; Deep Tech Startup.

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ATRAÇÃO DE INVESTIMENTOS EM *STARTUPS DEEP TECHS*: O EFEITO DA SUSTENTABILIDADE

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Resumo

Objetivo do estudo: Entender quais recursos explicam a atração de investimento para *startup deep techs*, e se a sustentabilidade é um dos fatores de atração de investimento.
Metodologia/abordagem: A partir de dados primários, aplicou-se análise de regressão logística em uma amostra de 220 *startups deep tech*s do Estado de São Paulo, Brasil.
Originalidade/relevância: Os desafios de sustentabilidade exigem a participação das *startups deep tech*s, porém é questionado se esse fator explica o investimento em *startups*. Com base na *Resource-Based View* (RBV), a pesquisa avança na literatura para explicar quais recursos explicam os investimentos dos grupos de sócios, governo e terceiros nas *startups deep tech*s.
Principais resultados: O investimento privado de terceiros é atraído por *startups* que tem recursos únicos no mercado. O investimento dos próprios sócios é impulsionado pela tecnologia proprietária. E o investimento governamental pelo desempenho superior da *startup*. Contudo, não existe uma associação da sustentabilidade com a atração de investimento.
Contribuições teóricas/metodológicas: Este estudo contribui para a literatura que relaciona investimento e recursos, ao mostrar especificamente como diferentes recursos direcionam diferentes investimentos. Contribui, também, de forma pontual e crítica ao evidenciar a ausência de associação entre investimento e sustentabilidade.
Contribuições sociais / para a gestão: Para os empreendedores de *startups deep tech*s, o estudo revela que diferentes recursos devem ser valorizados de acordo com o investimento que se pretende, seja de sócios, terceiros e governamental. Para os investidores em *startups deep tech*s, fica a importância de direcionar de maneira propositiva mais investimentos para negócios que visam resolver problemas socioambientais.

Palavras-chave: Sustentabilidade; Recursos Diferenciados; S*tartup Deep Tech.*

ATRAER INVERSIONES EN STARTUPS DE TECNOLOGÍA PROFUNDA: EL EFECTO DE LA SOSTENIBILIDAD

Resumen

Propósito del estudio: comprender qué características explican la atracción de inversiones para las *startups deep techs* y si la sostenibilidad es uno de los factores de atracción de inversiones.
Metodología/enfoque: Con base en datos primarios, se aplicó un análisis de regresión logística a una muestra de 220 *startups deep techs* en el Estado de São Paulo, Brasil.
Originalidad/relevancia: los desafíos de sostenibilidad requieren la participación de nuevas *startups deep techs*, pero es cuestionable si este factor explica la inversión en nuevas empresas. Con base en *Resource-Based View* (RBV), la investigación avanza en la literatura para explicar qué recursos explican las inversiones de grupos de socios, gobierno y terceros en *startups deep techs*.
Principales resultados: La inversión privada de terceros es atraída por startups que cuentan con recursos únicos en el mercado. La inversión propia de los socios está impulsada por tecnología patentada. Y la inversión del gobierno para un rendimiento superior de la *startup*. Sin embargo, no existe una asociación entre la sostenibilidad y la atracción de inversiones.
Contribuciones teóricas/metodológicas: Este estudio contribuye a la literatura que relaciona inversión y recursos, al mostrar específicamente cómo diferentes recursos dirigen diferentes inversiones. También contribuye, de manera puntual y crítica, al resaltar la falta de asociación entre inversión y sostenibilidad.
Contribuciones sociales / de gestión: para los emprendedores de *startups deep techs*, el estudio revela que se deben valorar diferentes recursos según la inversión prevista, ya sea de socios, terceros o gobierno. Para los inversionistas en *startups deep techs*, es importante dirigir de manera proactiva más inversiones a empresas que tienen como objetivo resolver problemas socioambientales.

Palabras clave: Sostenibilidad; Recursos diferenciados; *Startup deep tech.*

1 Introduction

Investments play a pivotal role in the survival and growth of startups (Bertello, Battisti, De Bernardi, & Bresciani, 2022). The literature has identified three primary sources of financing available to these enterprises, namely founders, government support, and third parties, including incubators, accelerators, angel investors, crowdfunding platforms, venture capital firms, corporate venture capital, and private equity (Bertello et al., 2022; Bocken, 2015; Marcus, Malen, & Ellis, 2013; Singh & Subrahmanya, 2022). Within the academic realm, significant interest has been devoted to comprehending the external and internal factors that facilitate startups in attracting these three sources of funding. External factors encompass alliances between firms (Hoenig & Henkel, 2015), ecosystem development (Kriz, Rumyantseva, & Welch, 2022), and market attractiveness (Gompers, Gornall, Kaplan, & Strebulaev, 2020). On the other hand, internal factors encompass startup resources such as human capital (Colombo & Grilli, 2010; Madsen, Neergaard, & Ulhøi, 2008), social capital resources (Madsen et al., 2008), strategic posture (Luo, Huang, Tang, & Li, 2021), legal protection (Islam, Fremeth, & Marcus, 2018), subsidies (Islam et al., 2018), team experience (Hoenig & Henkel, 2015; Singh & Subrahmanya, 2022), and investment in research and development (R&D) (Luo et al., 2021). In this study, grounded in the Resource-Based View (RBV) (Barney, 1991), the emphasis is placed on the internal factors, specifically the strategic resources of startups that attract financing sources.

However, among the aforementioned internal factors, exploring the dimension of sustainability assumes paramount importance. Notably, a mere 8.4% of the startups that received investments among the 19,997 startups in the 28 primary business ecosystems contribute to the United Nations Sustainable Development Goals (SDGs) (Tiba, Rijnsoever, & Hekkert, 2021). This discrepancy is disconcerting, since sustainability challenges necessitate the active involvement of startups (Bocken, 2015). In particular, it requires the engagement of deep tech startups, which are defined as “entities participating in the creation and advancement of science to derive financial returns from such involvement” (Pisano, 2010). These startups leverage cutting-edge technologies, such as artificial intelligence, machine learning, biotechnology, and nanotechnology to address environmental sustainability challenges. Given that deep tech startups are intricate business ventures (Miozzo & DiVito, 2016), possess extended return horizons (Neville & Lucey, 2022), and have the capacity to tackle sustainability challenges, it becomes imperative to investigate the extent to which environmental sustainability assumes significance in attracting investments for such companies. Consequently, the following research question emerges: To what extent does environmental sustainability matter for investment in deep tech startups?

The objective of this study is to investigate the significance of environmental sustainability as one of the internal factors impacting investment in deep tech startups. Specifically, drawing on the theoretical perspective of the RBV, this research focuses on unique resources (i.e., resources that are difficult to imitate, enable superior performance, involve proprietary technology, and embody intellectual property) in conjunction with environmental sustainability and their significance in attracting investments from founders, government, and third parties in the context of deep tech startups. To achieve this objective, a quantitative approach was adopted, and logistic regression analysis was applied to a sample of 220 deep tech startups in the state of São Paulo, using primary data. The results reveal a statistically significant association between certain unique resources and the three investment sources. However, no statistically significant association is found between sustainability and investment attraction.

This research offers three key contributions. Firstly, by linking the unique resources of deep tech startups with the three primary funding sources - founders, government, and third parties - this study contributes to the academic discourse in multiple domains. The finance literature acknowledges the importance of investigating factors that capture the attention of potential investors (Neville & Lucey, 2022). The entrepreneurship literature highlights gaps in understanding the critical resources of deep tech startups (Colombo & Grilli, 2010). The innovation literature, in turn, recognizes the significance of examining different types of financing for innovation collectively (Mazzucato & Semieniuk, 2018). Secondly, previous studies have predominantly examined funding sources in isolation. Some studies focus exclusively on government funding (Hulsink & Scholten, 2017; Luo et al., 2021), while others concentrate on venture capital (Bocken, 2015; Colombo & Grilli, 2010; Islam et al., 2018). Therefore, this study contributes to the literature by comparing the three funding sources. Lastly, from a practical standpoint, this study aids entrepreneurs in understanding the specific competitive advantages they should leverage vis-à-vis their competitors to secure optimal financing.

2 Theoretical Framework

2.1 Funding Sources

Throughout its trajectory, a company undergoes various stages of development and growth, each requiring funding sources that align with the typical operational activities, financial resource needs, and characteristics of the stage (Bygrave & Timmons, 1992; Pavani, 2003). For the focus of this article, which centers on companies in the early stages of development, funding sources can encompass equity capital, government-subsidized capital, and third-party capital. Equity capital represents funds contributed by the entrepreneurs themselves, supplemented by support from family members or friends who become partners. Government-subsidized capital comprises funds obtained through government funding programs, philanthropic entities, or corporations. Typically, these funds take the form of economic grants or awards and are influenced by government policies or corporate strategies. Third-party capital may stem from angel investors, venture capital, or corporate ventures. Angel investments involve individuals, often accomplished professionals or entrepreneurs, making investments in nascent companies, providing not only financial capital but also intellectual support by leveraging their experience and knowledge. Angel investors receive a minority equity stake in the business (Endeavor, 2021). Venture capital refers to investments made by legally constituted fund managers in smaller businesses with a high potential for financial returns, albeit associated with elevated risks and uncertainties. Conversely, corporate venture denotes investments made by fund managers aiming to fulfill the strategic objectives of corporations. In this study, the resources provided by entrepreneurs, family members, or friends will be considered as “investments from own partners.” Government-subsidized capital will focus on government funding programs, which will be referred to as “government investments.” Lastly, angel investors, venture capital, and corporate ventures will be deemed as “third-party private investments.”

Deep tech startups operate at the forefront of technological innovations, facing greater risks and uncertainties, requiring substantial capital, and demanding long-term funding sources (Gigler & McDonagh, 2018). Furthermore, due to the inherent nature of these companies, information asymmetry between funders and resource recipients is heightened, influencing uncertainty and further constraining investments in these firms. Recognizing the potential impact of new technologies and deep tech startups on the competitiveness of companies and regions, and consequently on economic development, numerous countries have been endeavoring to comprehend and stimulate the development of funding sources more tailored to these companies, aiming to overcome existing bottlenecks. Illustrative examples include

government programs aligned with technological strategies or targeting specific industries, blended finance programs where financing is associated with economic subsidy initiatives, and access to laboratory and financial infrastructure resources facilitated through universities (Nedayvoda, Delavelle, So, Graf et al., 2021). In this regard, access to external funding assumes paramount importance for the survival and success of deep tech startups, particularly during the early stages (Bertello et al., 2022; Luo et al., 2021; Neville & Lucey, 2022; Singh & Subrahmanya, 2022). Empirical investigations demonstrate that access to external funding significantly enhances the performance of these startups (Colombo & Grilli, 2010; Luo et al., 2021).

Nevertheless, the literature suggests that the inherent high risk associated with startups, attributable to the scarcity of historical operational information and the uncertainty surrounding future cash flows, detrimentally affects investment attraction (Gompers et al., 2020; Hoenig & Henkel, 2015). This information gap impedes investors' evaluation processes, wherein financial metrics, such as internal rate of return or multiple on invested capital (MOIC) are commonly employed to guide investment decisions (Gompers et al., 2020). To mitigate these informational asymmetries, startups can cultivate distinctive resources that are highly valued by the financial market (Islam et al., 2018).

2.2 Differentiated Resources and Financing of Deep Tech Startups

Differentiated firm resources can explain the attraction to startup investments. In this study, the RBV (Barney, 1991) is adopted as a theoretical lens to analyze the internal factors (resources) that attract financing sources. Following Helfat and Peteraf (2003), this study considers a resource as “an asset or input for production (tangible or intangible) that the organization possesses, controls, or has access to on a semi-permanent basis.” Resources can be sources of competitive advantage for innovative ventures (Zahra, 2021) as long as the resource adheres to the principle of heterogeneity (Barney, 1991). Thus, in this article, differentiated resources can be those that adhere to the principle of heterogeneity by being unique and difficult to imitate. In addition they maintain superior performance and are protected by intellectual property or proprietary technology.

Recent studies report the importance of startup resources in attracting financing sources (Colombo & Grilli, 2010; Hoenig & Henkel, 2015; Berger & Hottenrott, 2021; Islam et al., 2018; Luo et al., 2021; Madsen et al., 2008; Mann & Sager, 2007; Singh & Subrahmanya, 2022). Most of the consulted studies confirm that investors are attracted to aspects related to

the human capital of startups (Colombo & Grilli, 2010; Hoenig & Henkel, 2015; Madsen et al., 2008; Singh & Subrahmanya, 2022) and social capital (Madsen et al., 2008), which can be equated to the criterion of difficulty of imitation.

Another frequently cited resource is the technological potential of startups (Hoenig & Henkel, 2015; Islam et al., 2018; Luo et al., 2021),which aligns with superior performance and proprietary technology. Additionally, studies also highlight strategic posture (Luo et al., 2021), which aligns with being unique in the market. Lastly, regarding intellectual property, Cockburn and MacGarvie (2009) indicate that startups with patents are more likely to receive external funding, although some controversy is pointed out by Hoenig and Henkel (2015) and Islam et al. (2018). Therefore, relational capital, social capital, strategic posture, technological potential, and intellectual property present themselves as resources associated with an investment in startups. Generally, these are resources that are difficult to imitate (relational and social capital), unique in the market (strategic posture), possess superior performance (technological potential), and are derived from proprietary technology or are protected by patents (intellectual property).

Thus, it is understood that the financing of deep tech startups can be attracted by differentiated resources, i.e., those that are unique, difficult to imitate, guarantee superior performance, and are protected by intellectual property or proprietary technology. Therefore, the following hypothesis is proposed:

H1: The attraction of financing for deep tech startups is positively associated with differentiated resources.

2.3 Sustainability and Financing of Deep Tech Startups

Environmental sustainability remains a controversial issue for attracting investment in startups (Bocken, 2015; Lange, 2017; Tiba et al., 2021). Some studies indicate a positive effect of environmental sustainability, while others suggest a negative or null effect of sustainability on attracting investments in deep tech startups. Thus, following the direction of Bocken (2015) and Marcus et al. (2013), further empirical testing is necessary. Regarding the null or negative effect, a study on environmentally sustainable startups showed that they are not in a better position to attract investments (Lange, 2017). A similar result was found in the study by Tiba et al. (2021), in which only 8.4% of invested startups contribute to the Sustainable Development Goals (SDGs).

However, sustainability is also regarded as a differentiated resource for investments in startups (Bocken, 2015). Startups that prioritize sustainability can address environmental and

social externalities related to market failures, meeting the growing global interest in socio-environmental initiatives (OECD, 2020). Involvement in sustainable practices can leverage the startup's performance in numerous ways, such as developing radical innovations (Bocken, 2015; Schaltegger & Wagner, 2011), offering differentiated products (Schaltegger & Wagner, 2011), improving relationships with stakeholders (Nguyen & Adomako, 2021), and building legitimacy (Hegeman & Sørheim, 2021). Therefore, due to their potential to create value and the urgency of their solutions, startups that prioritize sustainability should be more attractive to investors than traditional startups. Thus, this study considers sustainability as a differentiated resource for deep tech startups.

Therefore, the following hypothesis is expected:

H2: The attraction of financing for deep tech startups is positively associated with environmental sustainability.

3 Methodology

The present study adopts a quantitative methodological approach to investigate deep tech startups in the state of São Paulo. This region is recognized as a conducive environment for the emergence of startups with a deep tech profile. São Paulo exhibits a strong commitment to R&D, as evidenced by its substantial investment of R$ 12.5 billion in 2018, which accounted for 73% of the total R&D investment made by Brazilian states (InvestSP, 2020). Moreover, São Paulo holds the 28th position in the global ranking of startup ecosystems and is widely regarded as the leading ecosystem in Latin America in terms of talent, experience, and funding. It is home to 2,770 startups, making it a thriving hub for entrepreneurial activities. Notably, the University of São Paulo ranks among the top 100 universities worldwide, boasting outstanding academic programs in the fields of science, technology, engineering, and mathematics (STEM). Furthermore, São Paulo serves as the Latin American base for numerous global banking institutions and houses several local venture capital firms, thus ensuring improved access to capital for the city's growing enterprises (Genome, 2022).

The identification of deep tech startups in São Paulo was executed through the utilization of two mechanisms. Firstly, the researchers opted to leverage the database of the Small Business Innovative Research Program (Programa Pesquisa Inovadora em Pequenas Empresas - PIPE). This program, initiated in 1997, operates under the auspices of the São Paulo Research Foundation (Fundação de Amparo à Pesquisa do Estado de São Paulo - FAPESP) and supports scientific and technological research endeavors undertaken by micro, small, and

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medium-sized enterprises across the state. The PIPE program encompasses the entire research process, commencing with the assessment of technical-scientific viability (Phase 1) and the formulation of research proposals (Phase 2) to the commercial and industrial implementation of innovative products, processes, systems, and/or services resulting from previous research (Phase 3). Consequently, in December 2021, the study targeted companies that had completed PIPE projects (Phases 1, 2, and 3) between 2017 and 2021, as well as those with ongoing projects. This comprehensive selection process yielded an initial sample size of 960 companies.

Additionally, given this research's interest in exploring diverse sources of investment, including third-party, partnership, and governmental, the investigation sought to identify deep tech startups associated with accredited entities within the São Paulo Technological Parks System, the São Paulo Network of Technological Innovation Centers, and the São Paulo Network of Business Incubators. To achieve this, the research team initiated correspondence with the representatives of these organizations, elucidating the nature and objectives of the study and requesting the identification of deep tech startups. Notably, the majority of the companies suggested by the representatives of these organizations had already been included in the initially compiled database, as they had previously received support through the PIPE program. As a result, based on the responses received, only 64 additional companies were deemed eligible and consequently incorporated into the initial sample.

Thus, the final dataset comprised 1,024 companies. To ensure the selection of startups that aligned with the research objectives, the following inclusion criteria were applied: i) registration of the startup in the state of São Paulo with an active CNPJ (National Registry of Legal Entities); ii) development of solutions utilizing cutting-edge technologies, including artificial intelligence, machine learning, IoT, blockchain, biotechnology, nanotechnology, big data, sensors and biosensors, biomaterials and new materials, additive manufacturing, drones and unmanned aerial vehicles (UAVs), augmented reality, virtual reality, robotics, and bioinformatics; iii) demonstration of tangible societal impact and potential for transformative change within their respective industry value chains; and iv) possession of an updated website and/or social media presence containing relevant information.

Based on these criteria, the dataset was further refined to include 373 startups. In the subsequent phase, a structured questionnaire was developed for primary data collection. The researchers initiated contact with the 373 selected startups, requesting the CEOs' participation in responding to the questionnaire. To enhance the response rate, email reminders and invitations to participate in the research were disseminated through social media channels to

companies that had not yet provided their responses. Ultimately, the final sample comprised 220 responses.

3.1 Variables

The dependent variables assess the investment in deep tech startups operating in the state of São Paulo. Table 1 presents the selected dependent variables, which serve as proxies for the investments received by the startups.

Table 1

Dependent variables utilized in the research

Variables	Description	Variable Calculation
Model 1	Private third-party investment	Dummy variable, taking a value of "1" for startups that indicated receiving any of the following types of investments: angel, pre-seed, seed, and venture capital; and a value of "0" otherwise.
Model 2	Investment from own partners	Dummy variable, taking a value of "1" if the startup indicated receiving investments from its own partners, and a value of "0" otherwise.
Model 3	Government investment	Dummy variable, taking a with a value of "1" for startups indicating receipt of research funding and a value of "0" otherwise.

Source: Authors' own elaboration (2022).

The independent variables are associated with the competitive advantages of the startup in relation to its competitors. Table 2 presents the six selected variables that served as proxies for the competitive advantage of the startups. Similar to the dependent variables, these variables are also dummy variables, taking on a value of "1" when the startup indicates the presence of competitive advantage and a value of "0" otherwise.

Table 2

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Independent variables utilized in the research

Description	Variable Calculation
Not Easily Imitated	Dummy variable, taking a value of "1" for the startup, which indicates not being easily imitated as a competitive differentiator of its solution compared to its main competitors; otherwise, it takes a value of "0".
Unique in the Market	Dummy variable, taking a value of "1" for the startup, which indicates being unique in the market as a competitive differentiator of its solution compared to its main competitors; otherwise, it takes a value of "0".
Superior Performance	Dummy variable, taking a value of "1" for the startup which indicates superior performance as a competitive differentiator of its solution compared to its main competitors; otherwise, it takes a value of "0".
Protected by Patent or Trade Secret	Dummy variable, taking a value of "1" for the startup, which indicates being protected by a patent or industrial secret as a competitive differentiator of its solution compared to its main competitors; otherwise, it takes a value of "0".
Proprietary Technology	Dummy variable, taking a value of "1" for the startup, which indicates proprietary technology as a competitive differentiator of its solution compared to its main competitors; otherwise, it takes a value of "0".
Environmental Sustainability	Dummy variable, taking a value of "1" for the startup, which assigns significant importance to environmental sustainability in the development of its solution; otherwise, it takes a value of "0".

Source: Authors' own elaboration (2022).

The control variable included in the study was the age of the startup. This variable considers the year of establishment of the startup. Age is important for control purposes, as investments can vary in their form depending on the length of time the company has been in existence.

3.2 Analytical Approach

The analysis was conducted using multivariate data analysis. To test the hypotheses proposed in this research, the logistic regression analysis method was applied (Fávero & Belfiore, 2017; Hair, Black, Babin, Anderson, & Tatham, 2009). The data processing was performed with the assistance of the Statistical Package for the Social Sciences (SPSS) software.

4 Results

The results using the dependent variables, specifically the types of investments received by the 220 respondent deep tech startups, are presented in Table 3 below. These findings reveal that out of the sample, 82 startups (37.3%) received private investments from third parties, encompassing angel investors, pre-seed, seed, and venture capital. Moreover, 164 startups (74.5% of the sample) received investments from their own partners, while 152 startups (69.1% of the sample) obtained government funding.

Table 3

Descriptive Statistics

Description	Frequency	Percentage
Private third-party investment	82	37.3
Investment from own partners	164	74.5
Government investment	152	69.1

Source: Authors' own elaboration (2022).

The findings revealed a substantial prevalence of resources originating from entrepreneurs themselves being allocated to their startups (74.5%). This practice, commonly known as bootstrapping, is widely employed by startup entrepreneurs. Often, this occurs because these companies fail to meet investor criteria, either due to their lack of qualification or as a deliberate choice by the entrepreneurs who believe that early-stage external investments may compromise their discipline and flexibility. Furthermore, external investors may hinder the trial-and-error approach necessary for success in uncertain environments where startups flourish (Bhide, 1992). The data also demonstrated a notable incidence of government funding being directed toward the respondent startups (69.1%). Government support plays a pivotal role in nurturing deep tech startups. As highlighted by BGC (2021b), governments and institutions form the backbone of investment in deep tech startups. Public capital provisions include grants for early-stage ventures, making governments the most significant risk-takers. The study emphasized that public bodies often subsidize specific industry segments, fostering favorable market conditions by reducing prices and costs. They also provide university laboratories and other assets to support researchers, act as regulators and policy facilitators for infrastructure, and offer project financing. The lower occurrence of private investments from third parties in this study (37.3%) can be attributed to risk aversion and a lack of familiarity with this type of startup. According to BGC (2021b), VC, PE, LP, and corporate funds exhibit risk aversion toward deep technology and are structurally ill-suited to invest in deep tech startups. Furthermore, they frequently lack the necessary expertise to comprehend advanced science and provide support for such ventures.

The majority of startups in our sample had been in operation for less than 6 years (129 startups), while others had a lifespan ranging from 7 to 12 years (77 startups). Only 14 startups had been operating for more than 13 years. Regarding distinctive resources, 74.5% reported proprietary technology, 55.5% reported superior performance, 51.8% reported difficulty in imitation, 43.6% reported market uniqueness, only 37.7% reported protection through patents

or trade secrets, and 45.5% reported environmental sustainability. It is evident that proprietary technology and superior performance were the primary reported distinctive resources, whereas sustainability received less attention.

Table 4 presents the results concerning the relationship between the control variable (year of foundation) and the independent variables (distinctive resources) with the dependent variables: private investment from third parties (Model 1), investment from founding partners (Model 2), and government investment (Model 3).

Hypothesis 1 posits that the attraction of funding for deep tech startups is positively associated with distinctive resources. The results indicated a statistically significant association between resources and all three sources of investment. Specifically, Model 1 (Table 4) revealed a positive and significant effect (β= 0.749, p < 0.05, R^2 0.124) of market uniqueness on private investment from third parties. Model 2 (Table 4) demonstrated a positive and significant effect (β= 0.951, p < 0.05, R^2 0.089) of proprietary technology on investment from founding partners. Model 3 (Table 4) exhibited a positive and significant effect (β= 0.629, p < 0.05, R^2 0.053) of superior performance on government investment. Therefore, the findings provide support for this hypothesis. Hypothesis 2 anticipated a positive association between the attraction of funding for deep tech startups and environmental sustainability. However, the results indicated no statistically significant association between sustainability and investment attraction. Consequently, H2 was not supported.

Table 4

Regression models

	Model 1			Model 2			Model 3		
	B	**Sig**	**Exp(B)**	**B**	**Sig**	**Exp(B)**	**B**	**Sig**	**Exp(B)**
Not Easily Imitated	.413	.169	1.512	.040	.904	1.040	.123	.689	1.130
Unique in the Market	.749	.016	2.115	.311	.366	1.365	.152	.629	1.164
Superior performance	.583	.059	1.791	-.383	.253	.681	.629	.040	1.876
Protected by patent or trade secret	-.523	.117	.593	-.126	.729	.882	.136	.681	1.146
Proprietary Technology	.713	.061	2.041	.951	.010	2.587	-.517	.170	.596
Environmental Sustainability	-.420	.166	.657	.255	.442	1.290	-.011	.972	.989
Year of foundation	-.002	.576	.998	-.004	.749	.996	-.002	.446	.998
Constant	-1.573	.000	.207	.455	.246	1.576	.719	.064	2.052

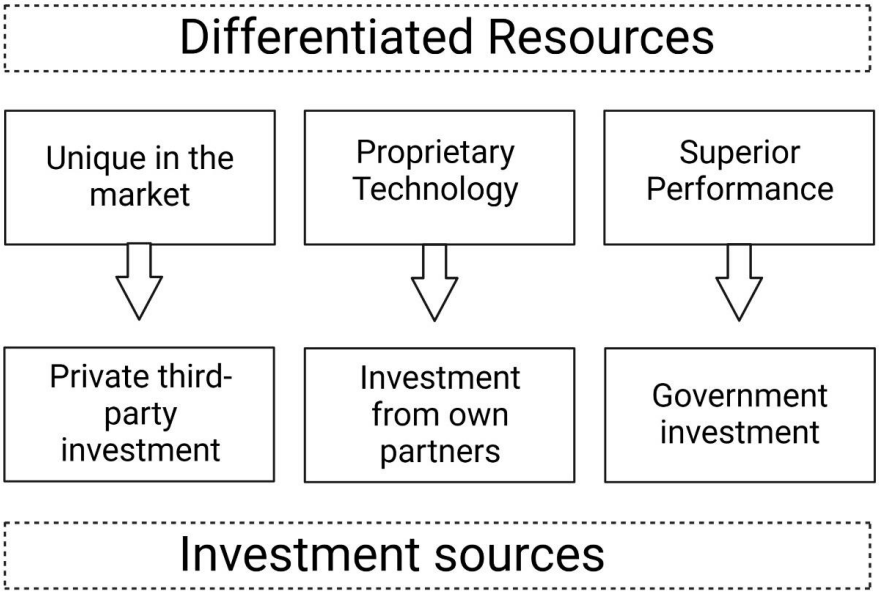
Source: Authors' own elaboration (2022).

In Figure 1, the predominant distinctive resources for each source of investment are presented, as identified by the research. Accordingly, to attract third-party private investments, market uniqueness emerges as a key factor. To secure investment from founding partners, the

presence of proprietary technology is deemed essential. Moreover, superior performance assumes paramount importance in attracting government investment.

Figure 1

The Impact of Distinctive Resources on Investment Sources



Source: Authors' own elaboration (2022).

5 Discussion

This discussion will address the contributions of this article to the literature and its managerial implications. Regarding the contribution to the literature, two aspects are addressed: one concerning studies that relate investment and distinctive resources, and another relating to studies that associate investment with sustainability.

Regarding investment and distinctive resources, the proprietary technology of deep tech startups shows a positive association with investments from founding partners. This finding aligns with previous studies that have demonstrates a significant and positive effect of technology on accessing external capital (Bhaird & Lucey, 2010; Neville & Lucey, 2022; Rin & Penas, 2007). However, this study is unique as it highlights the importance of proprietary technology for self-investment made by entrepreneurs. Proprietary technology can be considered a special type of resource, as it enables other strategic resources such as absorptive capacity (Rin & Penas, 2007), and tends to be imitated only in the long term, especially in slow-developing deep tech startups (Miozzo & DiVito, 2016), thus contributing to the competitive advantage of these ventures.

The second finding of this study pertains to the positive association of the resource "unique in the market" with third-party private investments, as suggested by previous studies (Hegeman & Sørheim, 2021; Leendertse, van Rijnsoever, & Eveleens, 2021). This result demonstrates that third-party private investors seek businesses that lack identified competitors in the market. One explanation for this is that engagement with unique startups can ensure financial returns for investors, along with strategic returns such as organizational learning.

The third finding of this study shows a positive association of "superior performance" with government investment, as verified by Lu et al. (2021). However, this study advances by focusing on deep tech startups, confirming which type of investor has favored investments in businesses that exhibit superior performance compared to other solutions in the market. One explanation for this is that as the government increasingly demands high performance from deep tech startups to subsidize them, it signals the quality of these ventures, thereby encouraging other investors.

Regarding investment and sustainability, the results deserve attention. They indicate that there is no effect of sustainability on investment attraction. This finding deviates from expectations since sustainable deep tech startups are recognized as actors capable of addressing environmental and social externalities associated with market failures (Bocken, 2015; Hegeman & Sørheim, 2021; Lange, 2017; Schaltegger & Wagner, 2011; OECD, 2020). Therefore, the question arises as to why such a result occurs. This can be explained by additional risks associated with sustainable businesses, such as a long-term investment (Bocken, 2015; Lange, 2017), exposure to unstable government regulations (Hegeman & Sørheim, 2021), uncertain financial returns (Hegeman & Sørheim, 2021; Lange, 2017), and a low percentage of sustainability-oriented business ecosystems (Tiba et al., 2021). Indeed, these are considerable risks, but it appears that there is a lack of sensitivity to the impact of deep tech startups. These companies, with disruptive solutions based on science and technology, address social and environmental challenges and have the potential to shape how some of the most pressing global problems are resolved. The power of deep tech startups lies in their ability to massively expand the space of options at an unprecedented pace and address fundamental problems. Science-based ventures contribute to addressing major issues such as the United Nations' Sustainable Development Goals. According to the study by BGC (2021a), which surveyed 1,277 companies in 2018 and 2019, many deep tech startups address more than one. Of the involved companies, 97% consider themselves as contributing to at least one UN SDG. Therefore, the lack of attention given to investments in these startups is concerning, as it may lead to fewer solutions being developed for relevant environmental problems crucial for the planet's development.

Regarding managerial implications, two audiences are addressed: entrepreneurs of deep tech startups and investors in deep tech startups. For entrepreneurs seeking external sources of funding, it is important to ensure, from conception to presentation to investors, the possession of proprietary technology, market uniqueness in their industry, and superior performance compared to potential competitors. Specifically, presenting a superior performance of their business is shown to be more relevant when approaching government investors, while highlighting technology ownership and market uniqueness is more crucial when approaching third-party private investors. Since sustainability does not seem to affect investment attractiveness as part of the business, it is recommended that entrepreneurs, to attract financial resources, primarily focus on developing and presenting differentiating resources in addition to sustainability.

For investors in deep tech startups, whether government or private institutions, it is crucial to proactively direct more investments toward businesses that aim to address socio-environmental problems. To build an interesting pipeline of sustainability-oriented businesses for investment, it is suggested to provide various types of support in addition to initial investment to researchers and early-stage entrepreneurs of deep tech startups. This support, such as mentoring, consulting, and training, can help guide high-potential businesses in developing important differentiating resources for their success and investment attractiveness. As previously highlighted in this study, greater investment attention in these startups can lead to more solutions being developed for relevant environmental problems, which is crucial for the planet's development.

6 Conclusion

This study was guided by the following research question: To what extent does sustainability matter for investment in deep tech startups? Drawing on the theoretical framework of the RBV, the study aimed to identify the distinctive resources that are most important for different groups of investors. The findings revealed that third-party private investment is primarily attracted by market uniqueness, self-investment by proprietary technology, and government investment by superior performance. However, the study found no evidence to support the notion that sustainability plays a significant role in attracting investment across any of the investigated investment categories. As such, the current research highlights the need for greater recognition and consideration of sustainability factors from the perspectives of third-party, self, and government investors.

While this study contributes valuable insights, it is important to acknowledge its limitations, which provide avenues for future research. Firstly, the study employed a dichotomous question format in the questionnaire to identify internal factors, which may not have fully captured the nuances of participants' perceptions. Therefore, future studies could employ a more nuanced scale format to enhance measurement accuracy. Secondly, the study only included one variable related to sustainability, thus future research should consider incorporating additional dimensions of sustainability to provide a more comprehensive analysis. Lastly, the sample was limited to deep tech startups located in the state of São Paulo, which may restrict the generalizability of the findings. Future research could expand the sample to include deep tech startups from diverse contexts, allowing for a broader understanding of investment dynamics in different regions or countries.

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