

ARTICLES

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THE EFFECT OF INNOVATION AND STRATEGIC RESOURCES ON CAPITAL STRUCTURE

O efeito da inovação e dos recursos estratégicos na estrutura de capital

El efecto de la innovación y los recursos estratégicos en la estructura de capital

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ABSTRACT

Innovation is crucial for competitive companies. To effectively implement innovation, it is necessary to have substantial financial resources. Traditionally, financing sources such as venture capital and angel investors are considered more suitable. In contrast, debt is considered less suitable due to the risky nature of innovation, which creates a negative association between innovation and debt. At the same time, the resource-based view emphasizes the importance of resources for successfully executing strategies. Therefore, we aim to identify the effect of the interaction of innovation strategy and strategic resources on companies' debt (capital structure). This finding is relevant since, despite the literature indicating that debt is inappropriate for innovation, it remains one of the most common sources of financing an innovative project. We show that a firm with an innovation strategy and strategic resources has greater financial leverage. The sample included American companies, covering 3,628 companies from 2008 to 2018.

Keywords: innovation strategy, capital structure, organization capital, knowledge capital, intangible capital.

RESUMO

Inovação é crucial para empresas competitivas, e sua implementação requer recursos financeiros substanciais. Tradicionalmente, fontes de financiamento como capital de risco e investidores-anjos são consideradas as mais adequadas. Em contrapartida, a dívida é considerada menos adequada devido aos riscos inerentes a inovação, criando-se uma associação negativa entre inovação e dívida. Ao mesmo tempo, a visão baseada em recursos enfatiza a importância dos recursos para a execução bem-sucedida da estratégia. Nesse sentido, este estudo trabalha com uma amostra de empresas americanas e examina dados do período entre 2008 e 2018, buscando identificar o efeito da interação da estratégia de inovação e dos recursos estratégicos no endividamento das empresas (estrutura de capital). Esse tópico é relevante uma vez que a dívida continua sendo uma fonte comum no financiamento da inovação, ainda que a literatura indique que ela seja inadequada para esse propósito. Os resultados mostram que uma empresa com estratégia de inovação e recursos estratégicos tem maior alavancagem.

Palavras-chave: estratégia de inovação, estrutura capital, capital organizacional, capital de conhecimento, capital intangível.

RESUMEN

La innovación es crucial para las empresas competitivas y, para su implementación, se requieren considerables recursos financieros. Tradicionalmente, se consideran más adecuadas las fuentes de financiación como el capital de riesgo y los inversores ángeles. Por el contrario, la deuda se considera menos apropiada debido a la naturaleza riesgosa de la innovación, lo que crea una asociación negativa entre innovación y deuda. Al mismo tiempo, la visión basada en recursos enfatiza la importancia de los recursos para la ejecución exitosa de la estrategia. Por lo tanto, en el presente artículo, pretendemos identificar el efecto de la interacción de la estrategia de innovación y los recursos estratégicos sobre el endeudamiento de las empresas (estructura de capital). Esto es relevante porque la deuda sigue siendo una fuente común de financiamiento de la innovación, aunque la literatura indique que es inadecuada. Nuestros resultados muestran que una empresa con una estrategia de innovación y recursos estratégicos tiene mayor apalancamiento financiero. La muestra incluyó empresas estadounidenses de 2008 a 2018.

Palabras clave: estrategia de innovación, estructura de capital, capital organizacional, capital del conocimiento, capital intangible.

INTRODUCTION

For many years, scholars have posited that firms operating in competitive markets are inclined to embrace innovation as a strategic means of sustaining their profitability (Dushnitsky & Lenox, 2005; Schumpeter, 1942). However, to sustain an innovation strategy, companies must raise funds to finance research and development (R&D) activities (Atanassov, 2015). The literature indicates that the most appropriate sources of financing for R&D activities are those with greater risk tolerance (Czarnitzki, 2006), such as venture capital (e.g., Gompers et al., 2020), angel investment (e.g., Wiltbank et al., 2009), and corporate venture capital (e.g., Dushnitsky & Lenox, 2005). On the other hand, debt financing sources for innovation projects are controversial.

In this context, the company's debt proportion can be represented as an indicator - "leverage." The greater a company's leverage, the more debt it has. With this indicator, it is possible to verify, in part, how the company defines its capital structure, which indicates how it finances its assets (Graham & Leary, 2011). Debt financing sources are considered the least appropriate for financing innovative activities (Elkemali et al., 2013; Kerr & Nanda, 2015). The reasons for this are related to the characteristics of innovation projects that lead credit providers to impose relevant financial constraints, such as high interest rates and incompatible payment terms (García-Quevedo et al., 2018; Hyytinen & Toivanen, 2005). Some of these characteristics of innovative projects are: the high degree of uncertainty associated with innovation output (Hall et al., 2016; Rajaiya, 2023), the specificity of the assets involved in R&D activity (Campello & Giambona, 2013; Williamson, 1988), and the unpredictability of cash flow (Choi et al., 2016; Robb & Robinson, 2014), among others.

However, although the literature suggests that debt is the least appropriate source for financing innovation, it is not uncommon for innovative companies (Choi et al., 2016; Robb & Robinson, 2014). One example is Tesla, Inc., which used debt for its innovative electric vehicles and sustainable energy projects. In 2010, Tesla received a loan from the United States Department of Energy worth USD 465 million. In 2017, Tesla issued a USD 1.8 billion debt bond to boost its innovation projects. With a book value of equity of approximately USD 5 billion and total debt of approximately USD 10 billion (Ofer & Raviv, 2023), we ask what makes Tesla and other companies decide to finance their innovative activity through debt. We believe this phenomenon arises because credit managers may perceive a company as less risky when it possesses strategic resources. Consequently, financial constraints imposed by the credit market decrease (such as high interest rates from a risk analysis), enabling the company to employ more debt to fund innovative projects.

The innovation strategy literature has widely studied the role of strategic resources in effectively implementing innovation-based strategies (IBS) (Faria et al., 2019; Helfat et al., 2023). The literature shows some positive effects of the presence of these strategic resources on efficiency (e.g., Chen & Inklaar, 2016; Eisefeldt & Papanikolaou, 2013; Hasan & Cheung, 2018), on increasing productivity (e.g., Baumann & Kritikos, 2016; Doraszelski & Jaumandreu, 2013; Li & Hou, 2019), and, most importantly, on competitive advantage (e.g., Bryant, 2003; Faria et al., 2019; Siddiqi & Rasheed, 2023).

Although strategic resources are essential in implementing IBS, few studies on innovation financing have considered them. Some important exceptions are the texts by [Singh and Hillemann \(2023\)](#), who indicated how a startup's need for resources varies according to its life cycle and modifies its financial constraints, and [Faria et al. \(2019\)](#), who addressed how the entrepreneur's relational resources influenced the acquisition of financing. To our knowledge, no research addressing innovation financing has considered the effects of strategic resources on a company's debt level.

Therefore, we believe the literature on financing sources and innovation strategy deserves further study. Thus, we aim to identify the effect of the interaction of innovation strategy and strategic resources on companies' debt.

We conducted a study with United States (US) firms that are listed on the main American stock exchanges (The New York Stock Exchange (NYSE), NASDAQ Stock Market (NASDAQ), and American Stock Exchange (AMEX)), reaching a total of 3,628 firms. The period analyzed ranges from 2008 to 2018 for 39,908 company-year observations. This period was chosen to address the decade prior to the effects of the COVID-19 pandemic, considering that the first news of the virus emerged in China in late 2019.

This article contributes to the literature by exploring a previously unaddressed point: the moderating effect of strategic resources and innovation on the level of debt. On the one hand, the literature provides ample evidence of a negative correlation between debt and innovation (e.g., [Atanassov, 2015](#); [Iqbal et al., 2022](#); [O'Brien, 2003](#); [Rajaiya, 2023](#)). On the other hand, we establish that introducing strategic resources ([Eisfeldt & Papanikolaou, 2013](#); [Peters & Taylor, 2017](#)) inverts the association and reveals a positive association between debt and innovation. In terms of practical implications, this suggests that in the presence of strategic resources, managers can utilize debt financing for innovative projects, similar to the approach adopted by Tesla.

THEORETICAL BACKGROUND

Innovation and financial constraints

The shift from a negative correlation between debt and innovation, as highlighted in the literature, to a positive correlation, as seen in cases like Tesla Inc., can partly be attributed to significant information asymmetry. Entrepreneurs typically know more about their projects' potential than financiers, creating a knowledge gap that can lead to increased financial constraints. Financiers might seek higher risk premiums or hesitate to invest due to limited insights ([Iqbal et al., 2022](#); [Su et al., 2022](#)). These constraints, acting as barriers to securing adequate funding for innovation, can be internal, such as low cash flow generation ([Guariglia, 2008](#)), or external, such as challenges in obtaining favorable external financing ([García-Quevedo et al., 2018](#)). Our study specifically addresses external constraints.

In addition to information asymmetry, another defining characteristic of innovation investment is the uncertainty regarding future revenues, largely dependent on factors such as market reception and the technological success of new products and processes (Czarnitzki, 2006; Hall et al., 2016). This uncertainty complicates result prediction, further fuelling financiers' apprehensions about these investments (Rajaiya, 2023) and increasing information asymmetry. Additionally, the temporal mismatch between cash outflows for R&D and subsequent inflows from realized innovations challenges traditional debt governance models, which are based on predictable returns (Choi et al., 2016; Robb & Robinson, 2014).

Other unique characteristics of innovation projects are the specificity and intangibility of assets. The specificity of assets concerns technologies acquired in the R&D process that have limited use outside their initial objective and little reuse in case of project failure (Choi et al., 2016; Hall, 2002). It reduces their liquidation value and the possibility of serving as collateral for debts (Campello & Giambona, 2013; Williamson, 1988). Additionally, most R&D expenditures involve paying the salaries of highly qualified scientists (Czarnitzki, 2006; Hall et al., 2016). To the extent that this knowledge is tacit and intangible, it is incorporated into employees' human capital and is lost if they leave the company (Choi et al., 2016; Hall et al., 2016). As a result, these assets cannot serve as collateral or support a high level of debt, generating even more resistance from creditors (Long & Maltiz, 1985).

Finally, innovative companies generate more investment opportunities (Brown et al., 2009). Agency theory suggests that, in these situations, shareholders prefer to increase equity capital, avoiding high debt costs. These companies also distribute lower dividends, as free cash flow is reinvested in innovation opportunities (Jensen & Meckling, 1976; Myers, 1977).

These characteristics combine to generate financial constraints in obtaining financing in the credit market (Hall et al., 2016; Hyttinen & Toivanen, 2005; Mina & Lahr, 2015; Revest & Sapio, 2012). As a result, there is a negative association between investment in innovation and debt financing (O'Brien, 2003). This association has been constantly tested in the literature using various measures of innovation inputs and outputs (e.g., Atanassov, 2015; Ayyagari et al., 2011; Elkemali et al., 2013; Ghosh, 2012; O'Brien, 2003; Wang & Thornhill, 2010).

However, to our knowledge, no other study has addressed the moderating role of resources in the association between innovation strategy and debt. These resources are discussed below from the perspective of the resource-based view (RBV) (Barney, 1991; Wernerfelt, 1984).

Resource-Based View and Hypotheses

The resource-based view (RBV) is one of the most tested theories in the administration field (Fernandes et al., 2017; Helfat et al., 2023). The central issue of RBV is that the company is seen as a "package" of resources developed over time, integrated, and explored in productive activities to provide value to the business (Wernerfelt, 1984). The RBV assumes heterogeneity and immobility of strategic resources between different companies (Barney, 1991). As a result, a company that

possesses and manages strategic resources that are valuable, rare, and relevant to imitation costs will have competitive advantages (Barney, 1991).

Numerous studies use the RBV as a background in their arguments and experiments. Resources related to the entrepreneur (Faria et al., 2019), relationships and networks with partners (Dyer & Singh, 1998), and leadership human resources (Bryant, 2003), among many others, are studied to explain the superior performance of companies. Within this perspective, some resources have gained space in the literature, such as organizational capital (Chen & Inklaar, 2016; Hasan & Cheung, 2018), knowledge capital (Doraszelski & Jaumandreu, 2013; Li & Hou, 2019), and intangible capital (Peters & Taylor, 2017; Venieris et al., 2015).

Organizational capital (OC)

Organizational capital (OC) is the set of management practices that allow for more significant operational performance (Lev et al., 2009). Furthermore, accumulated organizational capital integrates human management skills and physical capital to increase efficiency and enhance the company's ability to react and adapt to changing business environments (Hasan & Cheung, 2018). Therefore, OC is one of the most essential intangible resources in a company's organizational structure and technological infrastructure, as it facilitates the flow of knowledge to improve the firm's operational efficiency (Lev et al., 2009) and generate competitive advantages.

Considering the relevance of OC for achieving superior operational efficiency (Lev et al., 2009) and the company's performance and productivity (Chen & Inklaar, 2016; Tronconi & Vittucci, 2011), the literature has addressed this topic, correlating it with several other aspects at the company level. In this sense, organizational capital is crucial in explaining stock market returns in companies (Eisfeldt & Papanikolaou, 2013); contributes substantially to the increase in the market value of companies (Chen & Inklaar, 2016); is positively associated with the long-term performance of shares (Lev et al., 2009; Tronconi & Vittucci, 2011); explains a higher level of executive compensation (Eisfeldt & Papanikolaou, 2013); generates lower employee turnover and greater diversity of skills and salaries (Tronconi & Vittucci, 2011); and, most importantly, serves as a source of competitive advantage (Lev et al., 2009).

Therefore, we consider that the presence of OC in companies can mitigate the perception of risk associated with innovation strategies, reducing the financial constraints that these companies face. As a result, companies that adopt innovation strategies and have solid OC can assume higher debt levels. Based on this understanding, we formulate our first hypothesis:

H1: Companies with innovation strategy and organizational capital have greater leverage.

Knowledge capital (KC)

In turn, knowledge capital (KC) is the set of scientific processes and experiences (Baumann & Kritikos, 2016; Bournakis & Mallick, 2018; Li & Hou, 2019). The vast majority of studies addressing KC have identified that it has positive effects on increasing companies' productivity and a strong influence on companies' competitive position (Baumann & Kritikos, 2016; Bournakis & Mallick, 2018; Doraszelski & Jaumandreu, 2013; Li & Hou, 2019).

When measured through the investment stock in R&D, this resource contributes at a rate ranging between 65% and 90% to the productivity growth of companies in sectors with intermediate or high innovative activity (Doraszelski & Jaumandreu, 2013). Although the intensive use of KC has negative short-term effects on profitability, it has long-term benefits (Li & Hou, 2019). Additionally, the return on R&D investments is usually twice the long-term return on physical capital (Doraszelski & Jaumandreu, 2013). Thus, investments in KC are procyclical, so the extra productivity triggered by these investments can lead to a greater increase in profits in future periods of productivity growth, resulting in a significant increase in firm value, which is the sum of the present values of future profits (Li & Hou, 2019).

Therefore, we believe that the benefits generated by knowledge capital can mean that the risk perception of the innovation strategy can be reduced, affecting the financial constraints these companies suffer. Thus, companies with an innovation strategy and knowledge capital may have more debt. Thus, we propose our second hypothesis:

H2: Companies with an innovation strategy and knowledge capital have greater leverage.

Intangible capital (IC)

Intangible capital (IC) includes sources of future economic benefits that are not physically incorporated (Lev et al., 2009). In this research, we follow Peters and Taylor (2017) and define IC as the sum of the company's OC and KC.

The RBV postulates that IC is valuable as a resource base since it facilitates efficient interaction between tangible resources and firm management and provides the basis for organizational heterogeneity and immobility (Penrose, 1959; Wernerfelt, 1984). This finding is consistent with the view that an effective competitive advantage is obtained only through intangible resources (Bryant, 2003; Collis, 1994). This occurs because intangible resources, such as organizational culture, essential human competencies, and tacit knowledge, are rare and difficult to measure and identify because they are deeply rooted in the company's history and have accumulated over time (Wernerfelt, 1984).

Therefore, we believe that the presence of IC in companies with innovation strategies promotes a significant competitive advantage, influencing the market to estimate greater future returns and increasing the company's current value. This benefit mitigates the perception of

risk associated with innovation strategies, reducing the financial constraints these companies face. Therefore, companies with IC and innovation strategies can assume higher debt levels. Based on this understanding, we formulate our third hypothesis:

H3: Companies with an innovation strategy and intangible capital have greater leverage.

METHODOLOGY

The Capital IQ database was chosen as the data source. This study encompasses US companies listed on the main American stock exchanges (the New York Stock Exchange, the NASDAQ Stock Market, and the American Stock Exchange), resulting in a total of 3,628 firms. The period analyzed ranges from 2008 to 2018 for 39,908 initial firm-year observations. The chosen period covers an entire decade and does not include the effects of the COVID-19 pandemic since the first news of the virus emerged in China in late 2019. Accounting data refer to the end of each company's fiscal period. Furthermore, the sample does not include investment funds listed on those stock exchanges.

Following [Leary and Roberts \(2010\)](#), we excluded firms with capital structures governed by regulation, firms in the financial sector (Standard Industrial Classification (SIC) codes 6000-6999), firms in the utility sector (SIC codes 4900-4999), and firms with an invalid classification industry code (SIC codes 9900-9999). This last group mainly consisted of companies formed to carry out mergers, asset acquisitions, stock purchases, reorganizations, combining companies with diversified businesses, or having no relevant operational activity ([Leary & Roberts, 2010](#)). In addition, we follow [Peters and Taylor \(2017\)](#) and exclude any observations from our sample that have missing data on total assets and revenues or with less than USD 5 million in net fixed assets. This resulted in a final number of 2,208 different firms from 2008 to 2018 and 19,081 firm-year observations.

In addition, the final indicators used in the regressions were winsorized in the 1% tails (upper and lower). This winsorization is relevant for mitigating the effects caused by outliers and influential observations of the original sample ([Wooldridge, 2023](#)).

Constructs

Our dependent variable, the company's debt level, is measured using "leverage," which reflects the extent of a company's debt. Higher leverage indicates more debt, allowing us to assess the company's capital structure, i.e., how it finances its assets ([Graham & Leary, 2011](#)). Leverage is calculated by dividing the book value of long-term debt by the firm's total market value, derived from the sum of the total debt's book value and equity's market value ([Graham & Leary, 2011](#); [O'Brien, 2003](#)).

Our main independent variables are innovation-based strategy (IBS), organizational capital (OC), knowledge capital (KC), and intangible capital (IC). We show the construction of these variables below.

Innovation-based strategy proxy

Our primary independent variable, the innovation-based strategy (IBS) proxy, is derived from O'Brien's (2003) concept. This suggests that a company's innovation commitment is more accurately represented by its R&D intensity relative to industry competitors rather than just the magnitude of R&D intensity (R&D expenses divided by revenue). Thus, IBS is defined by comparing the firm's R&D intensity with its industry peers.

A firm's R&D intensity relative to its industry rivals indicates its strategic focus on innovation. High R&D spending does not automatically equate to innovation success (O'Brien, 2003), but firms investing more in R&D than competitors likely seek to innovate as a differentiator. For example, consider two firms in distinct industries with identical R&D intensities. If one firm exhibits the highest R&D intensity in its industry, whereas the other ranks at the bottom in its sector, it can be inferred that the former is striving to outcompete its industry rivals through innovation, while the latter may not be prioritizing innovation (O'Brien, 2003).

To construct the IBS proxy, we first calculate each firm's R&D intensity by dividing its R&D spending by its total sales. Then, we determine each sector's R&D intensity by dividing the total R&D expenditure by the total revenues of all companies within that sector, identified by their two-digit SIC code. We compare a firm's R&D intensity to its sector's, subtracting its R&D intensity from the sector's R&D intensity.

O'Brien (2003) did something similar by scoring the firm's R&D intensity in the sector. We applied both forms of comparison (subtraction and scoring), and they demonstrated statistical significance. We decided to maintain the comparison by subtraction because this indicator revealed greater economic significance than the comparison by scoring.

Organization capital (OC) proxy

The understanding of measuring OC in this study touches on the concept of stock, meaning how much of this resource firms have accumulated up to a given moment, following Lev et al. (2009). The main idea behind OC is that the SG&A (sales, general, and administrative expenses) accounting item includes all commercial operating expenses used to construct operating profit. A large part of SG&A includes information technology and employee expenses. Therefore, SG&As can be reflected in employee incentives, distribution systems, communication systems, and other OC resources (Eisfeldt & Papanikolaou, 2013; Lev et al., 2009).

Like Eisfeldt and Papanikolaou (2013), we use the idea that the OC stock is equal to the accumulated and deflated value of SG&A, as defined by Equation 1 below:

$$OC = (1 - \delta_0) * OC_{i,t-1} + \frac{SG\&A_{i,t}}{cpi_t}, \quad (1)$$

where $OC_{i,t}$ refers to the amount of OC stock of firm i at time t ;

δ_0 refers to the depreciation rate;

$SG\&A_{i,t}$ refers to the amount spent on SG&A expenses by firm i at time t ; and

cpi refers to the consumer price index.

Since this proxy construction refers to the value of a stock of OC, there must be an initial stock value as a starting point. The equation detailing the initial OC stock and the insertion of a depreciation rate (δ_0) are defined below, following the model of Eisfeldt and Papanikolaou (2013):

$$OC_{i,t0} = \frac{SG\&A_{i,t0}}{g_i + \delta_0}, \quad (2)$$

where $OC_{i,t0}$ refers to the amount of initial OC stock of firm i ;

$SG\&A_{i,t0}$ is the amount spent on SG&A expenses by firm i at the initial moment (the first observation of the sample);

g refers to the average annual growth rate of the SG&A expenses of firm i in the sample; and δ_0 refers to the depreciation rate.

Following Eisfeldt and Papanikolaou (2013), we used a depreciation rate of 15% in both equations.

Knowledge capital (KC) proxy

We use a proxy for KC borrowed from Peters and Taylor (2017), who claim that a firm builds KC through R&D spending. We use the same idea for constructing the stock of OC to construct the KC stock. However, instead of the central marker being SG&A expenses, construction is accomplished using R&D expenses. Therefore, the equations used are similar and given as follows.

$$KC_{i,t} = (1 - \delta_0) * KC_{i,t-1} + \frac{R\&D_{i,t}}{cpi_t}, \quad (3)$$

where $KC_{i,t}$ refers to the amount of KC stock of firm i at time t ;

δ_0 refers to the depreciation rate;

$R\&D_{i,t}$ refers to the amount of R&D expenses incurred by firm i at time t ; and

cpi refers to the consumer price index.

As in the case of the OC equation, we need a value for the initial KC stock so that the values can follow the proposed logic. The same solution is used, generating Equation 4:

$$KC_{i,t_0} = \frac{R\&D_{i,t_0}}{g_i + \delta_0}, \quad (4)$$

where KC_{i,t_0} refers to the amount of initial KC stock of firm i ;

$R\&D_{i,t_0}$ is the amount of R&D expenses incurred by firm i at the initial time (the first observation of the sample);

g refers to the average annual growth rate of R&D expenses of firm i in the sample; and

δ_0 refers to the depreciation rate.

We chose to use the depreciation rate of 15% for R&D in Equation 4, which is the most commonly used in other studies in the field, according to [Li and Hall \(2020\)](#).

Proxy of intangible capital

The IC is defined as the sum of the OC and KC stocks. [Peters and Taylor \(2017\)](#) use the same sum to define IC. Although an imperfect proxy, the authors' research has shown robust results in the literature regarding the measurement of IC in several ways.

The direction of causality between variables

An important aspect we need to examine is reverse causality. Reverse causality occurs when a dependent variable potentially affects independent variables ([Wooldridge, 2023](#)). While most research papers point to the influence of a firm's innovation-based strategy on its debt level ([Iqbal et al., 2022](#)), it is plausible to assume the possibility of reverse causality, in which debt level influences corporate innovation. For example, in their seminal article on agency costs, [Jensen and Meckling \(1976\)](#) indicated that the owner-manager of a company first issues debt and then decides on investments (strategy).

However, as our literature review indicates, our support theory is the resource-based view (RBV). The RBV shows us that a company defines its strategy based on its intangible and valuable resources ([Bryant, 2003](#); [Collis, 1994](#)) and then seeks the means to implement it successfully. Thus, in line with most studies on innovation and capital structure (e.g., [O'Brien, 2003](#)), we argue that defining an innovation-based strategy causes capital structure and not the other way around. Additionally, to provide more evidence for this causal relationship, we obtained results from a causality analysis based on the "Granger-Causality" approach, supporting the view that a company's leverage is caused by innovation and not vice versa ([Bartoloni, 2013](#)).

Regression model

We employed three fixed effects regressions, each corresponding to one of our study hypotheses. We decided to do this after we performed the Breusch–Pagan and Hausman tests (Wooldridge, 2023).

While these regressions share the same structural framework, they differ in terms of the specific proxy variable used to represent types of strategic resources: OC (for the first hypothesis), KC (for the second hypothesis), or IC (for the third hypothesis). In Equation 5, these strategic resources are denoted as SRs. Importantly, within a single application of Equation 5, the SR consistently represents the same resource type – it will represent the OC, KC, or IC throughout the equation.

$$Lev_{i,t} = \beta_1 * (IBS_{i,t} * SR_{i,t}) + \beta_2 * IBS_{i,t} + \beta_3 * SR_{i,t} + \gamma X + \alpha_i + \delta_t + \varepsilon_{i,t} \quad (5)$$

where $Lev_{i,t}$ refers to the proportion of the financial leverage of firm i at time t ;

$IBS_{i,t}$ refers to the proportion of how much firm i employs an IBS at time t ;

$SR_{i,t}$ is the amount of the SR stock of firm i at time t ;

X is a vector of control variables;

α_i represents the firm-specific (entity) fixed effects;

δ_t represents the time-specific (year) fixed effects;

$\varepsilon_{i,t}$ is the error term.

In Equation 5, leverage is measured by dividing the book value of long-term debt by the firm's total market value. The firm's total market value was calculated as the book value of total debt plus the market value of equity (Graham & Leary, 2011; O'Brien, 2003). Moreover, it is essential to control for the effect of other variables that could also be correlated with the firm's financial leverage level. The control measures are firm size, firm tangibility, firm capital intensity, sector profitability (return on assets, ROA), and the sector's market-to-book ratio (e.g., Aghion et al., 2004; O'Brien, 2003). Notably, although the literature indicates the effect of a firm's R&D intensity on leverage, it was decided not to use this variable as a control, as it is already reflected within the IBS variable (O'Brien, 2003).

We decided to use dependent and independent variables for the same period. This arrangement emphasizes the contemporary relationship between the independent and dependent variables. This approach is essential for capturing the direct influence of innovation strategy and current strategic resources on a company's leverage, reflecting the immediateness of the need to finance innovative activity, given the nature of sectoral dynamics and the company's strategic position in its market. It is particularly relevant for interpreting the interaction between innovation strategy and strategic resources, allowing a more explicit analysis of how this specific combination influences financial leverage.

However, we understand that using lagged independent variables in a regression analysis can be particularly useful for alleviating simultaneity problems, which occur when dependent and independent variables influence each other in the same period (Wooldridge, 2023). Therefore, we also carried out tests regarding a temporal arrangement, which considers the independent variables lagged by one period, in the same way as O'Brien (2003). These tests are discussed in the "Robustness" section.

ANALYSIS

Table 1 presents the descriptive statistics of the main variables used to compose the indicators for the regressions.

Table 1. Descriptive Statistics

	Mean	Median	p25	p75	min	max	se(Mean)	N
Leverage Ratio	0.227	0.177	0.083	0.321	0.001	0.832	0.002	13,242
ln(Size)	7.057	7.009	5.765	8.278	2.961	11.670	0.013	19,081
Capital Intensity	2.156	1.160	0.727	1.934	0.249	37.189	0.032	19,081
Net Tangibility	0.262	0.182	0.086	0.372	0.012	0.910	0.002	18,887
ROA (SIC Industry)	0.056	0.062	0.045	0.074	-0.101	0.123	0.000	19,081
Market-to-Book (SIC Industry)	1.253	1.175	0.900	1.643	0.294	2.828	0.004	19,081
IBS SIC	0.281	0.000	-0.023	0.061	-0.098	12.897	0.014	11,608
OC	0.708	0.468	0.215	0.920	0.019	4.179	0.005	18,894
KC	0.183	0.068	0.008	0.225	0.000	1.697	0.003	11,649
IC	0.973	0.733	0.393	1.261	0.053	4.966	0.008	11,621

Note: This table presents the means, medians, 1st and 3rd quartile values, minimum, maximum, and standard deviation of the averages and the number of observations for each of the main variables of the study. Leverage Ratio: book value of long-term debt divided by the firm's total market value. Ln(Size): natural logarithm of the firm's total assets. Net tangibility: value of net fixed assets divided by total assets. ROA (SIC industry): the industry's total net income divided by its total assets. Market-to-Book (SIC Industry): total equity market value of the industry divided by its total value of assets. The IBS SIC is the value of a firm's capital intensity minus its industry capital intensity. Capital intensity is the value of total assets divided by total revenue. OC (Organizational Capital), KC (Knowledge Capital), and IC (Intangible Capital) follow what was previously reported in the paper. The last column, N, refers to the number of observations for each item in the table.

Analyzing descriptive statistics provides important insights for understanding the relationships among innovation strategy, strategic resources, and the capital structure of companies. The Leverage Ratio averages 0.227. The variation is broad, as demonstrated by the minimum value of 0.001 and the maximum of 0.832, reflecting significant differences in financial leverage between the companies studied.

Concerning “ln(Size),” which measures the natural logarithm of the company’s total assets, the average is 7.057, again with a notable variation (minimum of 2.961 and maximum of 11.670), reflecting the diversity of operational scales. For Capital Intensity, the average is 2.156, with a lower median of 1.160, indicating a distribution skewed toward lower values, although the maximum value is 37.189. This may point to some companies with a much higher capital intensity. Net tangibility has an average of 0.262 and presents a substantial variation from 0.012 to 0.910.

Regarding industry variables, ROA averages 0.056, while Market-to-Book averages 1.253, suggesting a generally higher market valuation than book value in the industries considered.

The IBS, which measures a company’s capital intensity relative to its industry, has a mean of 0.281 and a wide range from -0.098 to 12.897, which may reflect substantial differences in capital intensity between companies and their respective industries. Finally, organizational capital has an average of 0.708, while knowledge capital has a lower average of 0.183, indicating greater investment in organizational capital.

Effect of strategic resources and IBS on the capital structure

Table 2 presents the main results of the regressions performed for the three research hypotheses.

Table 2. Fixed effects regressions of the joint effect of the IBS and Strategic Resources on Leverage – SIC Industry

	(1)	(2)	(3)	(4)	(5)	(6)
	OC Without Controls	OC With Controls	KC Without Controls	KC With Controls	IC Without Controls	IC With Controls
ln(Size)		0.007***		0.009***		0.007***
		(0.00)		(0.00)		(0.00)
Capital Intensity		0.005***		0.006***		0.005**
		(0.00)		(0.00)		(0.00)
Net Tangibility		0.119***		0.107***		0.103***
		(0.01)		(0.01)		(0.01)
ROA (SIC Industry)		-0.366**		-0.383**		-0.321*
		(0.13)		(0.14)		(0.14)
Market-to-Book (SIC Industry)		-0.034***		-0.032***		-0.036***
		(0.01)		(0.01)		(0.01)
IBS SIC	-0.015***	-0.027***	-0.028***	-0.047***	-0.030***	-0.044***

Continue

Table 2. Fixed effects regressions of the joint effect of the IBS and Strategic Resources on Leverage – SIC Industry

Concludes

	(1)	(2)	(3)	(4)	(5)	(6)
	OC Without Controls	OC With Controls	KC Without Controls	KC With Controls	IC Without Controls	IC With Controls
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)
OC	-0.038***	-0.037***				
	(0.00)	(0.00)				
IBS SIC * OC	0.011	0.016*				
	(0.01)	(0.01)				
KC			-0.135***	-0.104***		
			(0.01)	(0.01)		
IBS SIC * KC			0.039***	0.045***		
			(0.01)	(0.01)		
IC					-0.044***	-0.041***
					(0.00)	(0.00)
IBS SIC * IC					0.019***	0.023***
					(0.00)	(0.00)
Observations	7,122	7,094	6,942	6,914	6,928	6,900
R-squared	0.027	0.090	0.036	0.095	0.042	0.100
Year Dummy	No	Yes	No	Yes	No	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors are in parentheses

*** p<.001, ** p<.01, * p<.05

Note: This table provides the results of six fixed effects regressions on the joint effect of IBS and strategic resources on the Leverage Ratio. Standard errors (in parentheses) are robust and grouped at the company level. Leverage Ratio: book value of long-term debt divided by the firm's total market value. Ln(Size): natural logarithm of the firm's total assets. Net tangibility: value of net fixed assets divided by total assets. ROA (SIC industry): the industry's total net income divided by its total assets. Market-to-Book (SIC Industry): total equity market value of the industry divided by its total value of assets. The IBS SIC is the value of a firm's capital intensity minus its industry capital intensity. Capital intensity is the value of total assets divided by total revenue. OC (Organizational Capital), KC (Knowledge Capital), and IC (Intangible Capital) follow what was previously reported in the paper.

IBS and organizational capital

The first research hypothesis proposes that companies that combine an innovation strategy – observed by the innovation-based strategy (IBS) proxy – with organizational capital (OC) have

greater debt. This argument is based on the idea that organizational capital can mitigate the perception of risk associated with innovation strategies, reducing the financial constraints that innovation companies face. Thus, the presence of OC in companies that adopt innovation strategies allows these companies to assume higher levels of debt.

The regression results support this hypothesis. We see that the IBS variable is negatively related to leverage, corroborating the literature (Aghion et al., 2004; O'Brien, 2003). This relationship is statistically significant. At the same time, in the analysis with the control variables, the coefficient for the interaction between IBS and OC is positive (0,016) and statistically significant (0,016). According to our analysis of the control variables, this coefficient continues to be positive and statistically significant ($p < 0.05$).

The interpretation of these results suggests that OC effectively moderates the relationship between innovation strategy and financial leverage. Companies with a high OC level and IBS may have a greater capacity to take on debt due to the reduced risk of innovative activity. We believe this is coherent since OC strengthens a company's internal structure, improving its operational efficiency and ability to react and adapt to changes in business environments (Hasan & Cheung, 2018). In turn, OC can increase financiers' confidence in the viability and success of innovation projects, reducing information asymmetry and financial constraints.

IBS and knowledge capital

The second hypothesis formulated in the research suggests that companies that combine an innovation strategy with knowledge capital tend to have greater financial leverage. The central argument is that knowledge capital can also reduce the perception of risk associated with innovation strategies.

The results of the regression analyses also support this hypothesis. When we do not include control variables, the interaction between innovation strategy and knowledge capital has a coefficient of 0.039 with a strong positive relationship (significant at a level of $p < 0.001$). With respect to the control variables, this coefficient is larger (0.045) and still significant at the same level. This shows that the relation between the variables is robust and consistent.

These findings indicate that knowledge capital is crucial in mitigating the perceived risk associated with innovation, allowing companies investing in this resource to take on more debt. The results align well with the underlying theory. The resource-based view (RBV) suggests that valuable internal resources, such as knowledge capital, are fundamental to the success and competitiveness of companies (Barney, 1991). In the context of innovation strategies, knowledge capital not only boosts productivity and efficiency but can also improve a company's image in the eyes of creditors. This translates into greater confidence and willingness to provide financing, reflected in higher leverage. Therefore, these results provide empirical evidence supporting the theory that knowledge capital can effectively alleviate the financial constraints faced by innovative companies.

IBS and intangible capital

The third research hypothesis proposes that companies that combine an innovation strategy with intangible capital have greater financial leverage. The central argument is that intangible capital, comprising organizational and knowledge capital, provides significant competitive advantages. This occurs because intangible capital raises the estimate of future market returns and increases the company's current value, thus mitigating the perception of risk associated with innovation strategies.

Regression analyses, both with and without controls, show similar results. In the regression without controls, the interaction between innovation strategy (observed by the IBS proxy) and intangible capital (IC) has a coefficient of 0.019, which is significant at the $p < 0.001$ level. With respect to the control variables, the coefficient is 0.023, which is also significant at the same level. These results indicate a positive relationship between the combination of innovation strategy and intangible capital with companies' financial leverage, reinforcing that intangible capital significantly impacts companies' ability to take on more debt.

The interpretation of these results aligns well with the resource-based view (RBV) theory, which postulates that intangible resources are fundamental to companies' competitive advantage. Intangible capital is rare and difficult to imitate because it is deeply rooted in the company's history and culture. It contributes to heterogeneity and immobility, which are essential characteristics for maintaining a sustainable competitive advantage (Barney, 1991). This competitive advantage, in turn, increases the perception of the company's value in the market, leading to expectations of greater future returns (Peters & Taylor, 2017). This increase in the company's perceived value can reduce creditors' perception of risk, facilitating access to financing and allowing the company to maintain higher leverage levels. Therefore, the research results corroborate the idea that intangible capital is a valuable resource that can effectively alleviate the financial constraints faced by innovative companies.

Robustness

We carried out different tests to test the robustness of our study. In line with O'Brien (2003), we tested our independent variables lagged by one period, which proved significant with minimal coefficient changes. Additionally, we carried out tests disregarding the years of the financial crisis in the United States (2008 and 2009), a period characterized by widespread leverage constraints among firms (Cornett et al., 2011). Again, our results were robust, maintaining statistical significance.

Additionally, we tested the regressions with different constructions for the variables involving the sector (IBS, sector ROA, and sector Market-to-book). Traditionally, sector variables are constructed using SIC codes, characterizing an economic classification. However, since this research addresses an innovation context, a technological sectoral classification is also relevant. Thus, we used Pavitt-Miozzo-Soete's taxonomy (Castaldi, 2009; Castellacci, 2008). This taxonomy

was born from a rich database capturing critical details of innovative activity with the original study by Pavitt (1984). This study received several updates, including the works of Castaldi (2009) and Castellacci (2008), which combined the works of Pavitt (1984) and Miozzo and Soete (2001) to form a new, broader classification called the Pavitt-Miozzo-Soete (PMS), which is presented in Table 3. We used a transcription key between the SIC and PMS codes presented by Capasso et al. (2016). Therefore, this study uses SIC sector classification and PMS categorization to test its hypotheses. Once again, the results were robust.

Table 3. Industry categories by Pavitt-Miozzo-Soete (PMS)

Transformation industry	Service Industry
Science-based	Supplier Dominated Services
Specialized suppliers	Scale-Intensive Physical Networks
Scale intensive	Scale-Intensive Information Networks
Supplier dominated	Knowledge Intensive Business Services

Source: Adapted by the authors based on Pavitt (1984) and Miozzo and Soete (2001).

Additional tests were also carried out considering other constructions of the IBS variable, such as the division between the firm's R&D intensity by the sector's R&D intensity and the definition of a score of the firm's R&D intensity compared to the sector (O'Brien, 2003). All three constructions of the variable resulted in statistically significant values.

Some of these robustness tests are presented in Table 4.

Table 4. Robustness tests results

Dependent Variable: Leverage Ratio	Regression 1			Regression 2			Regression 3		
	IBS	OC	IBS * OC	IBS	KC	IBS * KC	IBS	IC	IBS * IC
Independent variables lagged by one period (SIC Industry codes)	-0.027***	-0.038***	0.018*	-0.044***	-0.105***	0.047***	-0.040***	-0.040***	0.022***
Independent variables lagged by one period (Pavitt-Miozzo-Soete's taxonomy)	-0.034***	-0.037***	0.022**	-0.049***	-0.103***	0.046***	-0.044***	-0.037***	0.022***

Continue

Table 4. Robustness tests results

Concludes

Dependent Variable: Leverage Ratio	Regression 1			Regression 2			Regression 3		
	IBS	OC	IBS * OC	IBS	KC	IBS * KC	IBS	IC	IBS * IC
Not employing financial crisis in the United States (2008 and 2009) (SIC Industry codes)	-0.030***	-0.031***	0.021***	-0.046***	-0.086***	0.041***	-0.044***	-0.032***	0.020***
Not employing financial crisis in the United States (2008 and 2009) (Pavitt-Miozzo-Soete's taxonomy)	-0.035***	-0.029***	0.023***	-0.050***	-0.086***	0.040***	-0.045***	-0.029***	0.020***
Pavitt-Miozzo-Soete's taxonomy	-0.034***	-0.031***	0.024***	-0.051***	-0.088***	0.043***	-0.043***	-0.031***	0.020***

*** p<.001, ** p<.01, * p<.05

Note: This table provides the results of multiple robustness tests, as previously described. All regressions also use control variables, which were removed from this table for the sake of brevity.

DISCUSSION AND FINAL CONSIDERATION

This research aimed to identify the effect of the interaction between innovation strategy and strategic resources on companies' debt. We use the RBV literature as our background, focusing on three strategic resources: organizational capital, knowledge capital, and intangible capital.

Although several studies present evidence of a negative relationship between debt and innovation (e.g., Elkemali et al., 2013; Kerr & Nanda, 2015), we showed that the correlation between debt and innovation could be positive when considering strategic resources. This occurs because the benefits caused by strategic resources can mitigate the risk perceived by debt creditors and, thus, reduce financial constraints.

In addition, Kerr and Nanda (2015) highlighted recent advances in the finance literature that can explain our results. For instance, high adjustment costs related to R&D investments (Kerr & Nanda, 2015) may prevent firms from pursuing their target leverage (e.g., Flannery & Rangan, 2006), making innovative firms less levered. However, some efforts to promote more innovation—such as clustering of innovative firms—reduce financial frictions and allow the firm to increase its debt leverage. From this point of view, we argue that strategic resources can also serve as a way to reduce financial friction and increase a firm's potential to raise more debt.

Limitations and future research

Our research, like any study, has limitations. First, it relies on a US-only database, limiting its generalizability to other countries due to diverse local characteristics. Future studies should consider databases from various countries. Additionally, since constructing some proxies (e.g., R&D) depends on data not widely available outside the USA, alternative proxies should be explored to include more countries.

Empirically, despite robustness checks and theoretical adjustments, we acknowledge limitations related to endogeneity, reverse causality, and simultaneity. Future research should focus on these issues using methods such as instrumental variables, the generalized method of moments (GMM) (Arellano & Bond, 1991), system GMM (Blundell & Bond, 1998), or quasi/natural experimental techniques.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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Aline Mariane de Faria: Conceptualization; Data curation; Formal analysis; funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – proofreading, and editing.

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