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The impact of coopetition strategies on the innovative capacity and performance of Portuguese firms – a comparison between SMEs and large firms

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The impact of coopetition strategies on the innovative capacity and performance of Portuguese firms – a comparison between SMEs and large firms

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Dissertation

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Contents

List of Tables

List of Figures

Resumo

O objetivo do estudo é explorar como diferentes estratégias de coopetição, tradicionais e híbridas, impactam o desempenho inovador das empresas portuguesas, e se impactam da mesma forma as pequenas e médias empresas (PME) e as grandes empresas.

Para testar as nossas hipóteses usamos dois métodos econométricos, modelos de regressão linear múltipla e de regressão logística, com desempenho inovador e atividades de inovação de produto e processo como variáveis dependentes. Recorremos à base de dados *Community Innovation Survey* (CIS) 2020, composta por uma amostra de 15.607 empresas portuguesas.

Entre as principais conclusões, constatámos que as estratégias tradicionais de coopetição são mais benéficas para as PMEs, em particular na promoção da inovação de produto, embora estas estratégias não melhorem significativamente o desempenho inovador nas grandes empresas. As estratégias de coopetição híbridas, envolvendo concorrentes e não concorrentes, mostraram benefícios limitados e específicos do contexto, particularmente na inovação de processo. Os resultados também destacam que a colaboração com não concorrentes, como fornecedores, clientes e entidades governamentais, impulsiona o desempenho inovador, enfatizando o valor de redes colaborativas diversificadas. Finalmente, a o impacto do tamanho da empresa não mostrou um impacto significativo na relação entre as estratégias de coopetição e a inovação, sugerindo que os benefícios da coopetição podem variar mais com o tipo de estratégia e parceiros envolvidos do que com o tamanho da empresa.

Este estudo fornece uma perspetiva empírica sobre o debate em torno das diferentes estratégias de coopetição e o seu impacto na inovação, com enfoque no contexto específico das empresas portuguesas. Ao analisar as estratégias de coopetição tradicionais e híbridas e a forma como afetam distintamente o desempenho inovador e a propensão para inovar das PME e das grandes empresas, esta abordagem pretende preencher uma lacuna na literatura, uma vez que poucos estudos se concentram em explorar o impacto da dimensão das empresas na adaptação das estratégias de coopetição para o desempenho e a propensão para a inovação.

Fornecendo informações que podem beneficiar tanto os gestores como as políticas públicas, as principais conclusões deste estudo realçam a importância de medidas de apoio que maximizem os benefícios da coopetição para as PME, que têm maior probabilidade de

ganhar com estas estratégias, ao mesmo tempo que incentivam as grandes empresas a explorar abordagens colaborativas alternativas que se alinhem melhor com as suas posições de mercado estabelecidas. E salienta, para a política pública, a importância de promover a criação de diferentes tipos de redes de inovação, tendo em consideração a dimensão da empresa e identificando os principais intervenientes que mais beneficiam das estratégias específicas de coopetição.

Palavras-chave: Desempenho Inovador, Estratégias De Coopetição, PMEs, Dimensão Da Empresa, Rede Colaborativa

Abstract

The purpose of this study is to explore how different coopetition strategies, namely traditional and hybrid, impact the innovative performance of Portuguese firms, and whether they impact small and medium-sized firms (SMEs) and large firms in the same way.

To test our hypothesis, we employ two econometric methods, multiple linear regression models and logistic regression models, with innovation performance and product and process innovation activities as dependent variables. We resort to the Community Innovation Survey (CIS) 2020 database, comprising a sample of 15.607 Portuguese firms in 2020.

Among the key findings, we conclude that traditional coopetition strategies are more beneficial for SMEs, particularly in driving product innovation, while these strategies do not significantly enhance innovation performance in large firms. Hybrid coopetition strategies, involving both competitors and non-competitors, showed limited and context-specific benefits, particularly in process innovation. The results also highlight that collaboration with non-competitors, such as suppliers, customers, and government entities, significantly boosts innovation performance, emphasizing the value of diverse collaborative networks. Finally, the interaction between firm size and coopetition strategies did not show a significant impact, suggesting that the benefits of coopetition may vary more with the type of strategy and partners involved rather than firm size alone.

This study provides an empirical perspective on the debate surrounding different coopetition strategies and their impact on innovation, focusing on the specific context of Portuguese firms. By examining both traditional and hybrid coopetition strategies and how they distinctively affect the innovative performance of SMEs and large firms, this approach intends to fill a gap in literature, as few studies focus on exploring the impact of firm size in tailoring coopetition strategies for innovation performance and propensity.

Providing insights that can benefit both managers and public policy, the key findings emphasize the importance of support measures that maximize the benefits of coopetition for SMEs, who are most likely to gain from these strategies, while also encouraging large firms to explore alternative collaborative approaches that better align with their established market positions. It also points out, for public policy, the importance of promoting the

creation of different innovation-network types, considering the firm size and identifying the key stakeholders who benefit the most from the specific coopetition strategies.

Keywords: Innovation Performance, Coopetition Strategies, SMEs, Firm Size, Network

1. Introduction

The Open Innovation (OI) paradigm was introduced by Henry Chesbrough as a counterpoint of the traditional vertical integration model or closed innovation model, which can be defined as "*the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation*" (Chesbrough, 2006).

With the diffusion of the OI paradigm, as a result of the economic development towards a globalized, digitized, and interconnected model, firms saw an opportunity to meet their knowledge and technology needs externally and, thus, leverage their business and potentially create markets outside the limits of their current activities (Chesbrough, 2003). This paradigm is creating a business ecosystem more extensive, collaborative and engaging with a wider number of actors (Chesbrough, 2012).

The concept of coopetition in OI literature is contentious regarding its viability for using competitors as sources of innovative knowledge. Some authors argue that collaborating with competitors is the least favoured option among external partners, due to the considerable risk of losing competitive advantage, resulting in limited interactions (Brunswicker & Chesbrough, 2018).

OI literature categorizes processes into outside-in (sourcing external knowledge), inside-out (sharing internal knowledge), and coupled processes (co-creation partnerships). The concept of coopetitive open innovation, where competitors cooperate with each other and third parties (e.g., networks, ecosystems), has emerged within coupled processes research (Roth et al., 2020). A convergent literature stream is investigating whether cooperation with competitor partners can be beneficial for OI (Bez & Le Roy, 2022).

The present study explores the role of coopetition in promoting innovation among Portuguese firms, with a particular focus on small and medium-sized firms (SMEs), which represent 99% of all firms, with 96,1% of these being micro firms (INE, 2022). This makes Portugal an interesting case study for exploring the effect of these strategies on SMEs.

According to INE (2024), from 2020 to 2022, about 14,4% of Portuguese firms cooperated with other firms or entities, with 5,7% collaborating in R&D and 4,7% in other innovation-related activities. Cooperation with external partners has grown by 5,3 percentage points compared to 2018-2020. Large firms are the most collaborative (41,5%), but medium-sized firms saw the most significant increase (5,8 percentage points). For innovation specifically,

large firms had the highest growth (5,5 percentage points). Preferred partners are suppliers (4,8%) and consultants, commercial labs and private research institutes (4,0%). Collaboration with competitors increased by 0,5 percentage points to 1,2%.

During 2020-2022, 44,7% of Portuguese firms engaged in innovation activities, slightly down from 48% in the previous triennium. In terms of size, 79,1% of large firms (employing 250 or more individuals) and 41,5% of small firms (employing 10 to 249 persons) engaged in innovation activities.

Innovation contributed 15,2% to total firm turnover, up from 13,8% previously, with a significant impact from products new to the firm (10,8%) rather than new to the market (4,4%). Innovation expenditures reached 3.382,4 million euros, increasing 23,63% since 2020.

In this context, coopetition emerges as a strategy that involves both collaboration and competition between firms, and has been explored, in recent literature, as a relevant factor for the development of innovation activities (Corbo et al., 2022). There are several examples of innovation partnerships between competitors, including, for example, coopetition relationships in the automotive sector, a highly competitive and constantly changing market, between Volvo and Uber, Tome Ionity (BMW, Daimler, Ford, Hyundai, Kia and Volkswagen), among others (Jiménez and Sanchis, 2023).

The present dissertation aims to differentiate between traditional and hybrid or network coopetition strategies (Bengtsson and Kock, 2000; Nieto and Santamaria, 2007; Dagnino, 2002), empirically prove if these strategies have a different impact on SMEs and large firms and assess which type of coopetition strategy most benefits large and small firms, given that the two types of firms have different constraints and objectives in their innovation strategies (Morris et al., 2007, Gnyawali, and Park, 2009).

Therefore, traditional coopetition involves a dyadic collaboration on innovation projects between two competitors, while they keep competing in other areas. From a management point of view, firms that implement coopetition strategies benefit from a greater capitalization of the knowledge generated in the partnership, access to more valued resources when compared to the ones emerging from collaboration with non-competitors, and greater influence in the market (Pellegrin-Boucher, Le Roy, and Gurău, 2013; Ritala and Hurmelinna-Laukkanen, 2009).

In turn, hybrid coopetition overtakes the industry boundaries and involves collaboration between several types of actors, including competitors, customers, suppliers, universities and others, forming a kind of network for innovation. This broader approach gives the opportunity to access more diverse resources, take advantage of synergies and gain more market power (Bengtsson and Kock, 2000; Dagnino, 2002).

Numerous empirical studies have emerged in an attempt to support this argument, demonstrating a pronounced heterogeneity in the effects of coopetition strategies on the firms' innovation activities and their innovative performance. On the one hand, the impact is positive and significant, as in the study by Fernandes et al. (2019), with 6.840 Portuguese firms, where coopetition exhibits a significant impact on innovation activities and the innovative performance of firms in various sectors, especially when product innovation activities are at stake. On the other hand, the impact may be negative in specific circumstances, such as if competitors belong to the same region (Le Roy et al., 2016). Other empirical studies show another type of relationship, such as Park et al. (2013), who demonstrated that the impact of coopetitive alliances of public firms in the semiconductor sector have on the innovative performance is in the shape of an inverted U.

Some authors (Oughton and Whittam, 1997; Morris et al., 2007; Gnyawali and Park, 2009) have dedicated their work to demonstrate that coopetition plays a particularly important role for micro, small and medium-sized firms (SMEs), since they usually face challenges in terms of limited resources (Corbo et al., 2022), such as human, infrastructure, financial, and risk sharing resources, when they develop innovation activities, and, for this reason, are unable to cover the entire innovation cycle on their own. In this way, SMEs benefit from collaboration with competing partners, through the sharing of costs, infrastructures and knowledge.

Corbo et al. (2022) highlight a gap in the literature regarding the size and type of organizations involved in coopetition strategies for innovation. Most studies focus only on large firms, neglecting the implications that may arise from differentiating between small and large firms on the relationship between coopetition and innovation.

The relationship between coopetition strategies and innovative performance of firms in the literature follows several ramifications, from assessing whether it affects incremental and radical innovations in the same way (Le Roy et al., 2016; Bouncken et al., 2018; Vanyushyn et al., 2017), assess the optimal intensity of competition and cooperation in the relationship

(Park et al., 2013), analyse the impact of the partner's geographic location (Barrales-Molina et al., 2022; Vanyushyn et al., 2017) or their contribution to the internationalization of the firm (Santos et al., 2021).

Thus, an empirical study is proposed to answer the following research questions:

1. What is the impact of coopetition strategies on the innovative capacity of Portuguese firms?
2. Is the impact of coopetition strategies on innovation consistent across micro, medium-sized and large firms?
3. How does the inclusion of different types of collaborative partners influence coopetitive relationships? Do both SMEs and large firms gain equally from these hybrid strategies?

In response to these questions, factors such as the size of the firm will be analysed (Fernandes et al., 2019; Le Roy et al., 2016; Estrada et al., 2015; Yang, 2020; Barrales-Moli et al., 2022; Vanyushyn et al., 2017; Park et al., 2013; Bouncken et al., 2018), collaboration with other innovation partners (Le Roy et al., 2016; Estrada et al., 2015; Vanyushyn et al., 2017), the intensity of R&D activities (Estrada et al., 2015; Yang, 2020; Bouncken et al., 2018; Park et al., 2014; Barrales-Moli et al., 2022; Santos et al., 2021), level of human capital (Le Roy et al., 2016; Estrada et al., 2015), sector's technology intensity (Vanyushyn et al., 2017) and export intensity.

This dissertation contributes to the current literature by analysing the impact of coopetition strategies on the innovative performance of Portuguese firms, focusing on quantifying the different impact through firm dimensions. It aims to enrich research on coopetition strategies within Portuguese firms, where the predominance of small businesses raises a higher importance to size factor and potential adaptations in public innovation policy. By exploring both traditional and hybrid forms of coopetition, this study will provide insights into the dynamics of collaborative innovation and its managerial implications for SMEs in Portugal.

2. Literature Review

2.1. Concept of coopetition and theoretical background

Coopetition, where two firms compete and cooperate simultaneously (Bengtsson and Kock, 2000), is a phenomenon that attracted the most attention since the seminal work of Brandenburger and Nalebuff, in 1996, culminating in the publication of the book "Co-opetition" (Jiménez and Sanchis, 2023), however, the term was first used by Ray Noorda, founder of the firm Novell (Nalebuff and Brandenburger, 1997).

Firstly, coopetition was explored in the light of Game Theory, with the book of Brandenburger and Nalebuff, as a "*win-win"* strategy, contrasting with the traditional theory presented until then, which stated that, in all games, there would always be a winner and a loser. The authors highlighted that the business equilibrium is achieved through simultaneous strategies of collaboration, to the extent that the value creation may require cooperative activities, and competition, when it comes to appropriating this created value. This strategy emerges as "co-opetition", used by the authors to describe an interfirm relationship whose objective is to create and capture value, at the same time, that is, to cooperate and compete (Nalebuff and Brandenburger, 1997).

The coopetition research focus on understanding the motivations behind the collaboration with competitors and why they are a relevant partner to maximize their performance.

By contrast, the rationale behind Resource-Based Theory assumes that firms, in their genesis, are a heterogeneous profile of resources, which are not easily transferred between firms. For that reason, the propensity for collaboration between firms comes from facilitating access to resources, such as skills, market share or market knowledge, or from sharing costs in the development of new resources, which, in turn, increase the cost-efficiency ratio (Bengstsson and Kock, 2000).

The collaboration dynamics between competitors is influenced by the similarity of their resources and their market commonality (market overlap), measured by factors such as short product life cycle and technology convergence (Tzu-Ju Ann Peng et al., 2011).

Thus, the more distinct and exclusive the resources of each, the greater is the tendency to cooperate, and on the other side, the greater the market overlap, the greater is the competition, creating pressures for the firm to be more efficient than its competitor (Tzu-Ju Ann Peng et al., 2011; Bengstsson and Kock, 2000).

Coopetition strategies for innovation can play a particularly significant role in leveraging research in a specific industry, through the sharing of R&D costs by the various competitors or through the availability of complementary resources, such as the sharing of infrastructures for the development of tests of new technologies. In addition, cooperative relationships can alleviate barriers to market entry due to insufficient resources (Markiewicz and Adamus, 2012).

Following the Resource-Dependence perspective, scholars see an opportunity to use coopetition strategies to mitigate uncertain market conditions caused by the scarcity of resources and facilitate its appropriation. In environments of high technological transformation and increasingly demanding consumers, where the firm's competitive advantage is focused on its dynamic capabilities that allow it to adapt its resource profile to the constantly changing business environment (Quintana-García and Benavides-Velasco, 2004), there's some resources that are only accessible through collaborative strategies, arising interdependences between the players in that market, e.g. competitors (Zacharia et al, 2019).

On the other hand, the paradoxical outcome of coopetitive relationships is discussed by Transaction–Cost Economics Theory. On one side, increased transactional costs due to market imperfections promote cooperative relationships between firms. The main sources of transaction costs of an alliance come from specificity, uncertainty and complexity of the environment, limited access to information, the continuity of transactions, and bureaucratic costs (Jones & Hill, 1988). On another side, this same strategy generates increased transactional costs, since when relating to a competitor, the firm needs to protect itself against opportunistic behaviours (Cygler and Sroka, 2017), since each one may try to maximize its individual output to the detriment of common goals (Quintana-García and Benavides-Velasco, 2004). In short, this theory discusses the challenge of finding the equilibrium of considering individuals and common goals simultaneously on a coopetitive partnership, so that the value of the common outputs of the alliance exceeds the opportunity cost of each firm and both firms can appropriate, in a balanced way, its benefits.

Early groundwork of coopetition literature was built on a dyadic coopetitive relationship, but more recently it was broadened to a network approach.

Dagnino (2002) defines coopetition as a strategy between competing firms that allows them to manage a partially convergent structure of interests and objectives and create value from the cooperative advantage it confers on them. In addition, it distinguishes between two types

of coopetition: dyadic and network. Dyadic coopetition describes the coopetition relationship between two firms at one level of the value chain (e.g., R&D activities) or more (e.g. R&D and production), while network coopetition is the strategy that encompasses more than two firms interacting simultaneously both at one level of the value chain only (e.g. buyer-supplier relationships) and at several levels of the value chain (e.g. business clusters).

Business relationships are influenced by the social context, and firms' economic actions depend on the actors who are part of this social network (Gulati, 1998). The origin of networks is close to the motivations behind the Resource-Dependence Theory, as the firm seeks to establish relationships with partners that give them access to strategic interdependencies (Gulati, 1998).

Within a coopetitive network, the firm has access to information, assets and status. Also, the more central its position is, which means the more interdependencies it maintains, the greater is the impact of the implications of cooperative relationships on itself and on other relationships not directly involved (Gnyawali et al., 2006). This interdependence or connectivity of the business relationships that form it, imply a greater effort to recognize its relative position and competitive strength to evaluate its power dynamics.

According to Bengtsson and Kock (2000), coopetitive networks are essentially characterized by the heterogeneity of resources, which, on the one hand, promote competition, since each firm has a competitive advantage, whether through specialized knowledge, skills, equipment or products. On the other hand, the heterogeneity of resources motivates firms to cooperate with each other to meet their need for external resources to ensure access to these unique resources or to share the costs of developing new resources for their market.

One specific type of network is clustering, that Porter (1998) defined as "*geographic concentrations of interconnected firms and institutions in a given field*". Clusters had already been pointed out by Porter (1998) as promoters of competition and cooperation, although he excluded from theoretical hypothesis that these two paradoxical relationships were developed by the same actors. Dagnino (2002) argues that within clusters firms cooperate with each other, to the extent that they compete for funding and public or private investment, but in situations of entry into new markets they end up cooperating in technological development activities, definition of industry standards and exploration of the new market. Firms organized in clusters, thus, benefit from cooperative advantages of value creation,

whether in terms of the information flows and knowledge creation, which they later appropriate.

Network Theory enables the discussion of different forms of coopetition, once a business network could be formed by simultaneously competitors and non-competitor partners, such as suppliers, customers, research centres (Bengstsson and Kock, 2000). Some authors pointed out that more complex networks, with a variety of partners, promotes a more diversified knowledge exchange, facilitating its application on innovation products and services (Nieto and Santamaria, 2007).

Yang (2022) explores the coopetition dynamics in cooperative R&D consortia, comprising both competitors and non-competitors' participants. The author divided these dynamics between firms in competition-dominated, cooperation-dominated, and coopetitive relationships, and proved that the relationship between the intensity of competition and its innovation performance is U-shaped, implying that a moderate level of competition in a consortium gives the firm access to complementary resources from non-competitors partners and similar resources from competitors, promoting its innovation performance.

Focusing now on OI literature, the concept of coopetition does not bring consensus regarding the viability of competitors as external sources of innovative knowledge.

Certain authors defend that the interaction with competitors in innovation activities is the least preferred among external partners, demonstrating that their interaction is quite limited, with the associated risk of loss of competitive advantage being pointed out as a reason (Brunswicker, and Chesbrough, 2018).

Other studies reveal that collaboration with competitors may have no positive outcome or even a financial loss. Belderbos et al. (2014), who developed a study on co-ownership of intellectual property, show that, in intra-industry co-patenting, there is a greater risk of overlapping the domains of patents application, making it difficult to appropriate value when compared to non-competitive partners. Thus, their quantitative study demonstrates that co-patenting with intra-industry partners and the firm's performance, measured through market value, is a statistically significant negative relationship. An interesting result of this research is related to the fact that firms with lower bargaining power, due to a lower market position and technological level, tend to enter into more co-patenting agreements with competitors because of their collaboration.

The OI literature can be categorized, theoretically, in outside-in processes, as external knowledge sourcing from, for example, customers, suppliers or competitors; inside-out processes, for example licensing, joint ventures, spinoffs; and coupled processes referring to co-creation partnerships and alliances (Enkel et al., 2009). The first two types of OI are a "*transactional flow of knowledge*" and not necessarily includes collaboration (Bez and Le Roy, 2022).

Among the research of coupled processes in open innovation domain, the concept of coopetitive open innovation was born as "*a situation where competitors cooperate not only with each other but also with third parties such as networks, platforms, communities, ecosystems or triple helices*" (Roth et al., 2020), that resembles the concept of hybrid or network coopetition. A convergent literature stream between OI and coopetition tried to assess if the cooperation with a competitor partner can be promising for open innovation (Bez and Le Roy, 2022).

Table 1 shows a summary of the different definitions of coopetition across the theoretical approaches analysed above.

Table 1: Summary of theoretical approaches on the concept of coopetition

Theories	Definition	Authors
Game Theory	"Win-win" strategy, where the business equilibrium is reached by simultaneous strategies of collaboration and competition, to create value and appropriate it, respectively.	Nalebuff and Brandenburger (1997)
Resource-Based View (RBV)	Strategy where firms share their heterogeneous and unique resources to enhance its dynamics capabilities and create value that they could not achieve so efficiently independently. This relation is affected by resources similarity and market commonality, each one pulling distinctively to cooperation and competition.	Bengstsson and Kock (2000); Tzu-Ju Ann Peng et al. (2011); Markiewicz and Adamus (2012)
Resource dependence theory (RDT)	Due to scarce resources, competitors are impelled to collaborate to gain access to valuable mutual resources, creating an interdependency dynamic.	Quintana-García and Benavides-Velasco (2004);

Network Theory	Coopetitive network aggregates multiple partners of an industry who are interdependent with each other, maintaining both cooperative and competitive interactions. The firm benefits more from its coopetitive interactions if the firms' position is more central.	Porter (1998); Gulati (1998); Dagnino (2002); Gnyawali et al. (2006)
Transaction Cost Economics (TCE)	Coopetition is presented as a strategy to reduce the market transaction costs. However, coopetition may increase those transaction cost due to the risk of opportunistic behaviour.	Jones & Hill (1988); Cygler and Sroka (2017)
Open Innovation (OI) Theory	Situation where competitors cooperate not only with each other but also with third parties such as networks, platforms, communities, ecosystems or triple helices, fostering knowledge sharing and innovation practices to the market.	Enkel et al. (2009); Brunswicker, and Chesbrough, (2018); Bez & Le Roy (2022)

The concept of coopetition has attracted increasing academic attention since the 90s and it is a recent and still poorly consolidated stream of research (Meena et al., 2023). The vagueness of the concept of coopetition arises in several ways, and there is no consensus in the literature regarding the nature of the phenomenon and the two opposing forces that compose it.

Bengtsson et al. (2010) identify two types of study streams in which their view of coopetition differs at the root of their concept, on the one hand they see coopetition as a context and on the other as a process.

The authors point out that the contextual approach is widely used in the analysis of the phenomenon at the level of networks, identifying that within a network a firm can maintain competitive relationships with firms and collaborative relationships with other firms and the set of these relationships gives rise to a cooperative environment. In this way, coopetition is not a concept that defines an individual relationship between firms and the competitive and cooperative nature are independent of each other.

In the process approach, coopetition arises from an interaction between two or more entities, in which these entities simultaneously collaborate and compete, which can happen in

different activities. For example, firms can cooperate in activities upstream in the value chain (input activities) and compete in activities close to the customer (Bengtsson and Kock, 2000).

However, even in the process approach, coopetition is seen by some authors as a phenomenon that occurs in a single continuum, that is, at one extreme there are cooperative relations and, at the other, there are strictly competitive relations. Between them, there are different types of cooperative relations in which the two forces are negatively correlated, if cooperation between firms increases, competition decreases. On the opposite pole, authors define that the relationship of cooperation and competition are two distinct but coexisting interactions within a cooperative relationship and, thus, in this same relationship strong competition and strong cooperation may predominate, that is, several combinations of cooperation and competition.

Given a variety of theoretical approaches and particularities of the coopetition phenomenon, it is important to identify which approach is being used to conduct this study. Therefore, we define traditional coopetition as a strategy where the firm simultaneously collaborate in innovation activities and compete with other firms, not necessarily in the same activities. It is important to note that coopetition literature explores interaction between competitor in a vast number of areas, however we retrained our concept on collaboration for innovation.

Besides that, we consider that cooperation and competition are two distinct strategies coexisting within the coopetitive relationship, however this aspect will not be analysed furthermore.

We also distinguish between traditional and hybrid coopetition; this last one concept was adapted from the Network Theory, and we defined as a strategy where a focal firm maintain coopetitive relationships with other firms and at least one cooperative relationship with one non-competitive partner. We employ the resource-based theory to analyse the effects of hybrid coopetition on innovation-related outcomes, since we expect that these strategies enhance the innovation performance or reinforce the development of innovation activities, by conjugating both similarity of resources from competitors and complementary resources from non-competitor partners, and, ultimately, create added value and appropriate it. However, according with TCE, these relationships are not exempt of the risk of opportunistic behaviour, therefore managers should be cautious on its implementation.

The benefits and risks intrinsic to coopetition strategies are complex and multifaceted for firms, since the two opposing forces that comprise this strategy, collaboration and competition, have distinct and even contradictory effects.

By exploring the collaborative dimension of coopetition, firms can access complementary resources that would not otherwise be available. Collaboration thus allows for synergy between the parties involved, maximizing the potential of shared resources. In the competitive dimension, coopetition enriches operations, triggers improvements in the firm's activities and products, driving the search for competitive advantages (Pellegrin-Boucher, Le Roy, and Gurău, 2013).

2.2. Hypothesis development

2.2.1. Coopetition strategies and innovative performance and propensity

In the specific context of innovation, Ritala and Hurmelinna-Laukkanen (2009) consider that the value creation in the innovation process is based on the transfer of knowledge. That said, its absorption capacity becomes decisive for the firm, that is, the ability to retain and understand the transferred information and exploit it internally (Cohen & Levinthal, 1990).

In this way, the coopetition strategy presents benefits, compared to other collaborative strategies, when applied to innovation activities. The absorptive capacity of the knowledge generated is greater among competitors, since they have a common base of resources and technological and market knowledge, thus reducing ambiguity in the relationship (Ritala and Hurmelinna-Laukkanen, 2009)

In addition, Ritala and Hurmelinna-Laukkanen (2009) mention that the coopetition strategy demonstrates a significant impact on innovation, in terms of market expansion. The horizontal nature of the collaborative relationship confers a more substantial influence on the market than traditional vertical collaborative relationships between non-competitors, allowing for more structural changes in the sector and a faster and more extensive diffusion of innovation. The authors point out that the effects of coopetition can vary, especially when distinguishing between incremental and radical innovation.

However, the complex nature of coopetition strategies is not without challenges and risks. Firms, by adopting this approach, incur risks that, initially, may seem less prominent, compared to collaborations with other types of partners. One of these risks is opportunistic

behaviour, where the competing firm seeks to capitalize on the knowledge generated in the collaboration for its exclusive use (Le Roy and Lasch, 2016). This behaviour can undermine the common goals of coopetition and diverting resources for individual gains.

Another significant risk is unintentional information spillover, where a firm may share knowledge outside the agreed boundaries, compromising the integrity of the partnership. These risks underscore the importance of strategic and diligent management of coopetition relationships, where transparency and trust are essential to mitigate the inherent challenges, as it has already been evidenced by the literature (Ritala, and Hurmelinna-Laukkanen, 2009; Bengtsson and Kock, 2000; Morris et al., 2007)

Given the empirical nature of the study to be conducted, it is important to analyse the previously published empirical work, which focuses on the impact that coopetition strategies have on the innovative performance of firms. In appendix I is described the systematic review to identify the relevant empirical review.

From a general overview, it is possible to state that coopetition has a positive effect on firms' innovation (Fernandes et al., 2019; Le Roy et al., 2016; Estrada et al., 2015; Yang, 2022; Bouncken et al., 2018; Park et al., 2014; Barrales-Moli et al., 2022; Vanyushyn et al., 2017; Santos et al., 2021), although in certain circumstances this impact is not significant. In addition, in the specific case of Park et al. (2013), whose object of study is alliances of public firms in the semiconductor sector, the impact of coopetition on innovative performance is in the shape of an inverted U, which means that the alliance between competitors benefits their innovative performance to a certain extent in terms of levels of competition and cooperation. After that point, the benefits are smaller and smaller. In this case, the authors concluded that cooperation-dominant alliances are more effective strategies than competition-dominant alliances and the benefits are maximized when it comes to an alliance with high levels of cooperation and moderate levels of competition.

On Le Roy et al. (2016), with a sample of 3.933 firms in France, coopetition strategies were shown to have no effect on incremental innovations, and, in the case of radical innovation, coopetition only has a positive impact when the partner is in Europe or the United States, and at the level of regional cooperation the impact is even negative. The same result was recorded by Vanyushyn et al. (2017), in which they analysed the impact of coopetition strategies on innovations that are new to the firm (incremental) and new to the market (radical), also considering the geographic location of the partner, domestic and international.

In this approach, with a sample predominantly composed of SMEs it was found that international coopetition has a positive impact on radical innovations but does not have an impact on incremental innovations. Domestic coopetition, on the other hand, has a positive effect on incremental innovations. This study also discusses the role of organizational innovation as a moderator of the relationship between international coopetition and innovation, highlighting that the greater the organizational innovation required by the cooperative relationship, defined as the "*adjustment of organizational routines and practices*", the lower is the benefit that the firm derives from the interaction with multiple international partners. Still focusing on the geographic dimension of the relationship between coopetition and innovation, Barrales-Moli et al. (2022) demonstrate that coopeting with only one competitor from a region, whether national or international, is worse than not coopeting, in terms of innovative performance, requiring coopetition with more than one firm to benefit from it.

In contrast, the econometric study developed by Bouncken et al. (2018), in Germany, whose sample was mostly SMEs, demonstrated that coopetition has a positive impact on the incremental innovation of firms, in the pre-launch and product launch phases, and only positively impacts radical product innovation in the launch phase.

Finally, focusing on literature about Portugal, the study developed by Santos et al. (2021), showed that firms that implement coopetition strategies are more innovative and, for this reason, are more likely to internationalize. Fernandes et al. (2019) showed that interaction with competitors positively impacts the development of product, process, and marketing innovation activities (inputs), as well as their innovative performance (output).

Table 2 shows the summary of the empirical studies analysed that have the CIS as a data source, due to the alignment with the database used in this dissertation, except for the studies by Boucken et al. (2018) and Vanyushyn et al. (2017). These last studies are relevant for the empirical analysis that will be developed, since its sample is mostly composed of SMEs.

H1: Coopetition strategies have a positive impact on firms' propensity to innovate and, consequently, in their innovative performance.

Table 2: Synthesis of the relevant empirical literature

Authors	Location	Sample (firms)	Inclusion of other partners	Dependent variable	Variable significance: coopetition
Fernandes et al. (2019)	Portugal	7.995	-	Innovation Activities (Product, Process and Marketing) and Innovative Performance	(+)**
Estrada et al. (2015)	Belgium	627	Customers, Suppliers, Knowledge Institutes, Government	Product innovation performance (turnover)	(+)*
Le Roy et al. (2016)	France	3.933	Customers, Suppliers, R&D Institutions. Universities, other firms or network	Radical and incremental product innovation	(-)*, $(+)^{n.s.}$ - Regional $(-)^{n.s.}$, $(+)^{n.s.}$ - Nacional (+)***,$(+)^{n.s.}$ - Europa (+)***,$(+)^{n.s.}$ - US $(-)^{n.s.}$, $(-)^{n.s.}$ - Outros
Santos et al. (2021)	Portugal	6.840	-	Product or process innovation	(+)**
Boucken et al. (2018)	Germany	1,049 NPD (new product development) alliances – more than 70% SMEs	-	Incremental and radical innovation	(+)***,$(+)^{n.s.}$
Vanyushyn et al. (2017)	Sweden	9.839 (mostly SMEs)	Customers, Suppliers, Universities	New-to-firm and new-to-market innovation	(+)**,$(+)^{n.s.}$ (domestic coopetition) $(-)^{n.s.}$, (+)**(international coopetition)

** p<0.05; **0.001<p<0.01; ***p<0.001*

(+) positive and significant impact; $(+)^{N.S.}$ non-significant positive impact $(-)^{N.S.}$ Non-significant negative impact

2.2.2. Differentiating between traditional and hybrid coopetition strategies

Bengstsson and Kock (2000) argue that the traditional approach to coopetition is not at all the most correct. The firm' strategy depends on its position in a business network, which, in turn, is formed by a collaborative network, in which the firm interacts with various actors, from suppliers, customers, competitors, universities, Research and Development centres, establishing relationships of various natures. In this network, relationships can be horizontal or vertical, of a collaborative or competitive nature, or cooperative and, within this, with various degrees of cooperation and competition. These relationships become dependent on each other and have a major impact on their use of resources.

The diversity of partners in collaborative networks, as evidenced by Nieto and Santamaria (2007), favours innovation more than collaboration with a single partner, promoting access to diverse sources of information, which in turn facilitates the transfer and application of knowledge. If, on the one hand, the presence of competitors in these collaborative networks is beneficial due to the similarity of resources they have, facilitating communication and knowledge exchange, allowing the sharing of costs of developing innovation activities and reducing their risk. On the other hand, all non-competing partners bring great added value in terms of access to complementary resources.

Teece (1986) defines innovation as "*technical knowledge on how to do better than the state of the art*", composed of codified and tacit know-how. Codified knowledge is easier to transmit and, on the contrary, tacit knowledge is not easily replicable, as it depends on the firm's own experience.

In the context of a collaborative network, it should be composed of partners who provide tacit knowledge, that is, technological and market expertise – provided by competitors; and by partners providing complementary and synergetic resources. These circumstances will culminate in a commercially successful innovation, because of a complementarity of different resources and combination of similar resources (Yang, 2022).

H2: The type of coopetition strategy distinctively influences the innovative performance of firms and their propensity to innovate.

H3: Adding more collaboration partners to the coopetition strategy increase the effectiveness of their collaboration strategies on promoting higher innovative performance.

2.2.3. Impact of firm size in coopetition strategies for innovation

Although coopetition is already a strategy with great relevance in the literature and with a relatively sustained base of theoretical and empirical studies, namely, from 2016 onwards (Jiménez and Sanchis, 2023), the dimension factor is still quite neglected, and in most academic work is carried out based on large firms. Few studies focus on the relationship between coopetition and innovation in SMEs (Gast, 2015; Corbo et al., 2022).

However, it has been proven that the impact of coopetition strategies on SMEs is different from that of large firms (Bouncken et al., 2018), and it has different motivations, benefits and risks (Morris et al., 2007), and even within SMEs, micro and medium-sized firms have different motivations to collaborate.

When the spectrum of competition in the coopetition strategy is analysed, it is clear that SMEs are more sensitive to market fluctuations and, when compared to large firms, there is a greater risk of opportunism and knowledge leakage. In addition, SMEs may have a greater incentive not to contribute to the innovation activity (Yang, 2022) or their contribution to the cooperative relationship may not be a sufficient incentive for the partner, for example due to a lack of financial or human resources (Morris et al. 2007).

If, in one hand, large firms can easily appropriate the outcomes of a coopetitive relationship, SMEs can obtain greater marginal benefits than large firms, as they are in an unfavourable situation from the outset, with high R&D costs, greater instability and lack of available resources to innovate. The motivations for cooperating boil down to (1) high R&D costs and lack of financial resources, (2) shrinking product life cycles, (3) needs for technological convergence, (4) weak market presence, (5) limited ability to influence suppliers (Gnyawali and Park, 2009; Morris et al. 2007).

Gomes-Casseres (1997) already mentioned the importance of SMEs forming alliances to achieve economies of scale and scope, as well as to strengthen their position in the market. In addition, Oughton and Whittam (1997) introduced the concept of collective external economies of scale in the specific context of SMEs, based on Marshall's previous study. In sectors characterised by the presence of a few large firms and many SMEs, SMEs face great difficulties in competing with large firms benefiting from internal economies of scale, so the solution lies in their collaboration. In his academic work "*Principles of Economics*", Marshall makes this distinction between internal and external economies of scale and shows that

collaboration between firms promotes technological development and innovation (Oughton and Whittam, 1997).

Gnyawali and Park (2009) state that the fact that SMEs ally themselves with partners with complementary resources can contribute to the reduction of uncertainty and to greater technological convergence, since these firms tend to be more specialized in terms of technology and product (Morris et al. 2007) and, in this way, they are able to access another type of knowledge.

In a coopetitive relationship between large firms and SMEs, the large firm contributes with more extensive knowledge and experience and the SME offers its specialized knowledge, capable of predicting trends more accurately in that specific branch (Ketchen et al, 2007).

Due to limited resources, it is expected that SMEs will be more protective of these resources when interacting with competitors, when compared to large firms, which have a more sustained position in the market and more resources to protect its knowledge. In this way, innovative performance may be below optimal for SMEs when they collaborate with competitors, since "*collaborative innovation depends on the free flow of ideas and knowledge. Restricting this flow will prevent the network's opportunity from building wealth*" (Ketchen et al., 2007).

In addition, this collaboration may lead to a dependence on the SME, since it will have a greater proportion of its resources committed to the collaborative relationship and may be dependent on resources made available by the large partner firm, making it difficult to retract the partnership if necessary (Ketchen et al., 2007). One way to reduce this dependence may arise by incorporating other types of collaboration (hybrid coopetition) or investing in developing resources internally (Roessl et al., 2010), thus arising a need to add other types of collaboration with non-competitors to the coopetition.

H4: The impact that coopetition strategies have on innovation propensity and performance is not transversal to all firm sizes.

H4a: Coopetition strategies have a greater impact on the innovative performance of SMEs than in large firms.

H4b: Hybrid coopetition strategies are more effective for SMEs.

H4c: Traditional coopetition strategies are more effective for large firms.

Figure 1 illustrates the theoretical framework that supports this dissertation and the definition of the hypotheses to be tested.

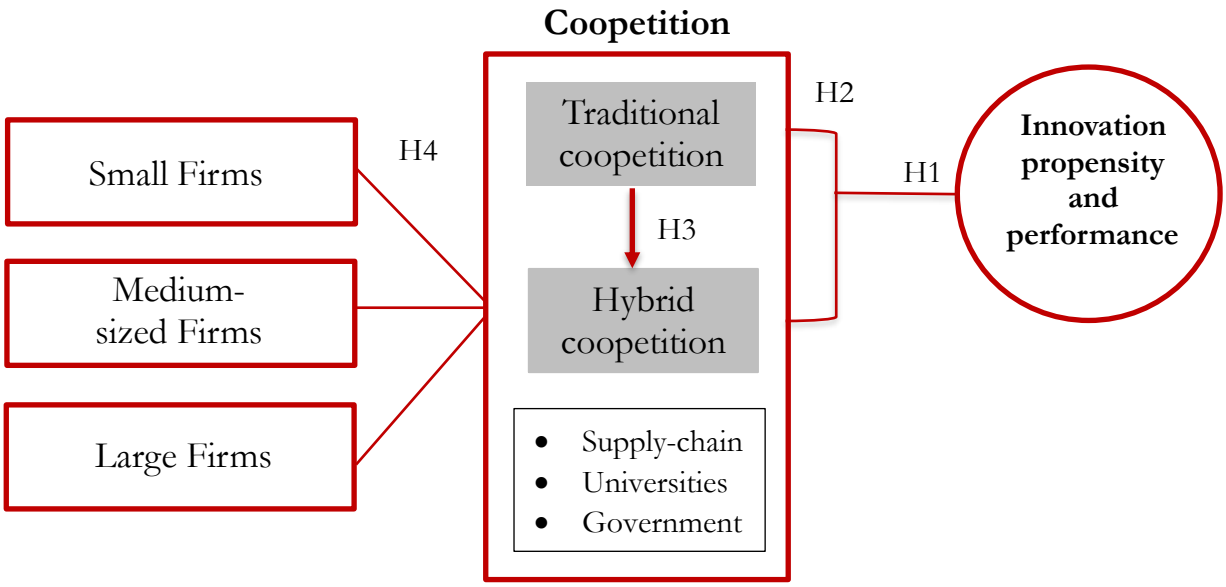


Figure 1: Theoretical framework and hypothesis formulation

3. Materials and Methods

This study has a particular focus on the reality of Portuguese firms, which presents an interesting case study for exploring strategies of coopetition in fostering innovation, particularly within its small and medium-sized firm (SME) ecosystem.

Approximately 99% of Portuguese firms are categorized as SME (INE, 2022) and, within these, 96,1% are micro firms. However, despite their prevalence, SMEs contribute to 61,34% of the country's wealth creation, as measured by gross value added (Pordata, 2022) and SMEs in 2021 were responsible for 70% of total employment (INE, 2024).

In the European economic context, SME represents 99,8% of all firms and Portugal ranks third-highest country with more SME representative, behind Greece and Italy (Eurostat, 2024).

The distribution of Portuguese firms across sectors is diverse, with significant representation in administrative services (15%), wholesale and retail trade (15%), consultancy, scientific and technical activities (10%), agriculture, farming of animals, hunting and forestry (9%), tourism (8%), human health and social activities (8%), construction (7%) and manufacturing (5%).

In the period 2018-2020, 48% of firms developed innovation activities. A comparison between SMEs and larger firms reveals a substantial gap, with only 45% of micro firms (employing 10 to 49 persons) engaging in innovation activities, in contrast to 63,3% of medium-sized firms (50 – 249 employees) and 84% of larger firms (employing 250 or more individuals). Among these activities, process innovation accounted for 42,7%, while product innovation represented 22,3%.

The impact of innovation activities on turnover is significant, with the introduction of new or improved products to the market contributing to 13,8% of total firms' turnover, in which 10,8% represented micro firms, 12,9% medium-sized firms and 15,8% large firms. However, comparing with the CIS2018, micro and medium firms exhibit the higher growth (3,2 and 3,1 percentage points), indicating a convergence between innovation patterns of distinct size groups.

Additionally, 10% of firms involved in innovation activities received public financing during the 2018-2020 period (INE, 2022).

Expenditures on innovation during these three years reached 2.735,8 million euros, increasing 5,8% compared to 2018.

This context underscores the role of SME in shaping the Portugal's economy and highlights their potential to drive the country's innovation agenda.

It is important to assess the innovative performance and effort of Portuguese firms at the European level. To do a comparative analysis with others EU Member States we use the European Innovation Scoreboard (EIS), which collects several Research and Innovation performance indicators and then segregate countries into four groups, based on their performance: innovation leaders, strong innovators, moderate innovators and emerging innovators. The scores are evaluated through an indicator framework with 32 indicators distributed in 12 dimensions grouped in four main types of activities, such as framework conditions, investments, innovation activities and impacts.

Portugal is between the moderate innovators, according to EIS 2023 and its innovation performance is growing at a decreasing rate, pushing it away from EU mean. Portugal stands out in various categories, such as, foreign doctorate students, government support for business R&D, public-private co-publications, broadband penetration and international scientific co-publications. However, one of the indicators dropping low since 2022 was Innovative SMEs collaborating with other (-14,6%), with a performance relative to EU in 2023 of 50,3%.

The empirical analysis conducted in this study rely on the data collected from the CIS, which is a biennial statistical study about firms' innovation harmonized through all EU State-Members. In Portugal, this study is conducted by Directorate General for Education and Science Statistics (DGEEC) and National Statistics Institute (INE).

We are using the CIS 2020, which data refers to the period of 2018-2020. CIS 2020 considered a population of firms located in Portuguese territory, with 10 or more personnel, from sections A to S of CAE – the Firm Activity Code, except section O. From this universe, it was selected a sample of 15.607 firms and were collected 13.509 valid responses, a total of 87% of the sample. The CIS sampling frame is defined by the variables economic activity (CAE), firm size (according with the number of employees) and geographical region (NUTS II).

Aligned with the relevant empirical research, we chose the most common data source, which has been also used in studies involving Portuguese firms (Fernandes et al., 2019; Santos et al., 2021). Alongside with the relevant innovation related data (types of innovation activities:

product, process, marketing, organizational), CIS provides firm-level data that can be useful for the analysis, such as activity sectors, firm size, turnover and sources of cooperation.

Recovering the research questions already mentioned:

1. What is the impact of coopetition strategies on the innovative capacity of Portuguese firms?
2. Is the impact of coopetition strategies on innovation consistent across micro, medium-sized and large firms?
3. How does the inclusion of different types of collaborative partners influence coopetitive relationships? Do both SMEs and large firms gain equally from these hybrid strategies?

The objective of this research lay on assessing the causality effect that coopetition strategies have on innovative capacities of firms and understand if this effect differs between firm' sizes. For this matter, the most adequate method to use is the quantitative, in which will be evaluated the relation between coopetition and innovation, based on the preview literature findings ("*Introduction to quantitative research*", 2010).

Through Table 3 it is possible to recognize that the relevant literature on this topic used quantitative related methodologies, more specifically regression analysis, such as logistic regression models (Fernandes et al., 2019; Santos et al., 2021; Le Roy et al., 2016), negative binomial regression models (Park et al.,2014 and Yang, 2020) and panel data analysis (Barrales-Molina et al., 2022 and Park et al.,2014).

Facing the purpose of our study and the nature of the dependent variables (continuous and binomial), we conducted firstly a multiple linear regression model, to understand the relationship between coopetition strategies and innovative performance and compare the effects of traditional and hybrid coopetition strategies on innovative performance.

Secondly, to assess the impact of allocating different coopetition strategies according with the firm size on the probability of engaging in innovation activities, we will compute a logistics regression model.

These methodologies will provide robust insights into the impact of coopetition on innovation, if they have a similar impact on SMEs and large firms and the effectiveness of different strategies according with their size.

Table 3: Synthesis of the empirical literature

Authors	Country	Number of observations/firms	Methodology	Data source
Fernandes et al. (2019)	Portugal	7.995 firms (6.840 observations)	Logit model Multiple linear regressions	CIS 2012
Santos et al. (2021)	Portugal	6.840 firms	Logit model	CIS 2012
Le Roy et al. (2016)	France	3.933 firms	Dichotomous logit model and odds ratio	CIS 2004
Boucken et al. (2018)	Germany	1049 NPD alliances	Covariance-based structural equation modelling (CB-SEM)	Hoppenstedt, Amadeus and German Bundesanzeiger (2012-2013)
Estrada et al. (2015)	Belgium	627 innovative manufacturing firms	Tobit regression and standard regression analysis	CIS 2007
Park et al., (2014)	Global	Alliance of public firms operating in the semiconductor industry (SIC 3674).	Comprehensive panel data (1990–2003) Negative Binomial Regression	Compustat; Securities Data Company; Factiva; National Bureau of Economic Research; USPTO and Google patent
Yang (2020)	Japan	649 firms in 50 Japanese R&D consortia.	Negative binomial regression	Nikkei Telecom21; Telecom21; Nikkei ValueSearch; Japan Platform for Patent Information
Barrales-Moli et al. (2022)	Spain	321 spanish biotechnology firms (1605 observations)	Panel data firm-level analysis with fixed effects	Spanish Technological Innovation Panel (PITEC) survey (2012–2016)
Vanyushyn et al. (2017)	Sweden	9.839 firms and 29.564 form-year observations	Bivariate probit model	Swedish CIS 2008–2014

Table 4 below summarizes the variables used in the models to test our hypothesis, as well its measurement, supported by relevant literature and the respective theoretical dimension discussed above in the literature revision. Each variable was retrieved from CIS2020 questionnaire which surveyed Portuguese firms respond to.

Table 4: Variables description

Theorical Dimension	Variables	Description of the proxy
Dependent variables		
Innovation performance	INNOV_PERFORM	Proportion of 2020 sales resulting from introducing new or significantly improved products within 2018-2020.
Innovative capacity	PRODUCT_INNOV	Dummy-variable that assumes the value 1 when the firm implemented product innovations and 0 otherwise.
	PROCESS_INNOV	Dummy-variable that assumes the value 1 when the firm implemented process innovations and 0 otherwise.
Explanatory variables		
Traditional coopetition	COOP_COMP	Dummy-variable that assumes the value 1 when the firm collaborated with competitors and 0 otherwise.
Hybrid coopetition	COOP_SUPPCHAIN	Categorical variable that assumes the value 1 when the firm collaborated with suppliers or clients, 2 when the firm collaborated with competitors and suppliers or clients and 0 otherwise.
	COOP_UNIV	Categorical variable that assumes the value 1 when the firm collaborated with universities or public research organizations, 2 when the firm collaborated with competitors and universities or public research organizations and 0 otherwise.
	COOP_GOV	Categorical variable that assumes the value 1 when the firm collaborated with state organizations, 2 when the firm collaborated with competitors and state organizations and 0 otherwise.
Firm Size	SME	Dummy-variable assuming value 1 when the firm is medium size (50-249 workers), 2 when it is large firm (more than 250 workers) and 0 when the firm is small-sized (10-49 workers).
Control variables		
Knowledge creation	I_D_INTER	Dummy-variable assuming value 1 when the firm performed internal R&D activities and 0 otherwise.
Absorptive capacity	HUMANCAPITAL	Scale variable that ranges from 1 (0% of workers with tertiary academic degree) to 7 (75%-100% of workers with tertiary academic degree)
Sector's technology intensity	INT_TECH	Scale representing the technology degree or knowledge intensity of the sector classified into low-technology firms (1), less knowledge-intensive services (2), medium-low-technology (3), medium-high-technology (4), knowledge-intensive services (5), high-technology (6) and 0 if unclassified.
Exporting Intensity	EXPORT	Approximate percentage of the firm's 2020 sales derived from exports.

3.1. Dependent variables

In line with previous research on the impact of coopetition on innovation performance and capability (Estrada et al., 2015; Fernandes et al., 2019; Le Roy et al., 2016; Santos et al., 2021) and the data collected from CIS 2020, we considered as our dependent variables the types of innovation carried out by the firms, such as product and process innovation[1], and the percentage of 2020 sales resulting from introducing new or significantly improved products (goods and/or services), within the years 2018-2020.

The variable reflecting product innovation activities (PRODUCT_INNOV) was measured by the introduction, during the period 2018-2020, of new or improved goods and/or services. In turn, process innovation (PROCESS_INNOV) reflects if firms, during the same period, introduced new or improved processes in at least one of the following categories: production or development of products or services; logistics, delivery or distribution; information processing or communication; accounting or other administrative operations; procedure organization or external relations; methods of job organization, decision making or human resources management; marketing for promotion, packaging, prices, post-sale products or services.

3.2. Independent variables

To assess the effect of coopetition strategies on firms' innovation performance, we resourced to the CIS data referring to what types of cooperation partner for innovation the firms had been maintained between 2018-2020, aggregating partners located in Portugal, other countries of EU or EFTA or other countries.

Our purpose is to capture the impact of traditional coopetition strategies on innovation performance and, for that, we included a dummy-variable evaluating the existence of competitors as partners in cooperation for innovation (COOP_COMP), as other studies already included before (Fernandes et al.,2019; Le Roy et al., 2016; Estrada et al.,2015; Bouncken et al., 2018; Park et al., 2014; Vanyushyn et al., 2017; Santos et al., 2021).

[1] CIS2020 uses has a conceptual framework to define different types of innovation activities the Oslo Manual (DGEEC, 2022), in which a product innovation is "*a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market."* And process innovation is defined as "*a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and that has been brought into use in the firm."* (Oslo Manual, 2018)

CIS 2020 also provides information about non-competitors partners (Le Roy et al., 2016; Vanyushyn et al., 2017; Estrada et al., 2015), such as suppliers of equipment, materials, components or software, clients, universities or others high education institutions, public research institutes. Regarding collaboration with the government, we use the CIS question "*during the period 2018-2020, indicate if the firm received public financial support from local and regional authorities, Central Administration, Horizon 2020 EU Program for Research and Innovation, other financial support of EU institutions*" to measure the collaboration with this partner.

To test the effect of hybrid coopetition strategies on innovation performance, we compute three categorical variables for each partner mentioned above (COOP_SUPPCHAIN, COOP_UNIV, COOP_GOV) reflecting if the firm, during the referring period, only collaborate with the noncompetitor partner (1), collaborate with noncompetitor partners and with competitors (2) or the absence of collaboration for innovation with that partner (0).

The effect of firm size was assessed using a variable obtained from CIS2020, assuming 1 if it is medium, 2 if it is large and 0 if it is micro, according to the number of employees (SME). In our logistics models, we divided the sample into SME's and large firms to evaluate whether the likelihood of engaging in product and process innovation activities is influenced by firm size. The variable size is commonly included in the literature on this specific topic, however as a control variable (Fernandes et al.,2019; Le Roy et al.,2016; Estrada et al.,2015; Yang,2020; Bouncken et al.,2018; Barrales-Moli et al.,2022; Vanyushyn et al.,2017; Park et al.,2013).

3.3. Control variables

As previous literature has already shown, innovation performance is influenced by a wide range of factors and, for that reason, we need to control for these variables, such as knowledge creation, measured by internal R&D activities (I_D_INTER); absorptive capacity, reflected by human capital qualification (HUMANCAPITAL); sector's technology intensity (INT_TECH), which was classified according to with CAE (business activity code) and the correspondent Eurostat indicators on High-tech industry and Knowledge – intensive services as Table 3 shows (in Appendix II is described all the NACE codes and the corresponding category); and exporting intensity of the firm (EXPORT), that reflects the proportion of 2020 sales resulting from clients located in other EU countries and EFTA and other countries outside EU.

3.4. Exploratory analysis

Table 5 gathers CIS2020 data about how Portuguese firms - across small, medium, and large firms - engage with different types of collaboration and the corresponding innovation outcomes.

Small firms, which dominate the Portuguese entrepreneurial context, show the highest efforts in both product and process innovation, with 53,27% and 60,20%, respectively. However, there is a potential to improve their innovative performance, because only 22,91% of small firms are engaging in product innovation, contrasting with 51,70% of large firms. This gap suggests that small firms are recognising the importance of investing in input types of innovation and there is a latent potential that could be unleashed with better resources or support systems to ensure that those efforts result in real added value for firms. When we look at process innovation, we conclude that even though large firms contribute 8,08% for this innovation type, this represents 68,47% of the total of large firms inquired.

Collaboration with government figures - through public financial support - appears as the most frequent interaction for firms, indicating that Portugal focus on fostering innovation through public initiatives and Portuguese firms rely on these entities to secure external sources of knowledge. Notably, small firms (59,06%) lead in collaborating with government, indicating a possible dependence on external funding sources to boost their innovation activities. Medium-sized firms, on the other hand, seek for universities and public research institutes (44,92%) as innovation partners, a strategy that aligns with their need for technical expertise and innovation partnerships to scale, and for clients and/or suppliers (42,18%).,

Collaboration with competitors is almost inexistent, with only 1,44% of firms engaging in this strategy, among them, small firms represent the largest share (42,27%). The overall reluctance of firms to collaborate with competitors may reflect a traditional Portuguese business culture, which tends to favour more secure, government-backed partnerships over riskier types of collaboration, as cooperation with competitors.

Large firms have the lowest percentages across most categories, but if we focus specifically on the proportion of large companies within their own group rather than the total, we see that collaboration strategies are more widespread among these firms, indicating a consistent involvement in these cooperation activities.

On the attempt to observe the network effect, we gather data about the firms that, in the period of 2018-2020, interacted with competitors, government, universities, clients and/or suppliers. This analysis resulted in identifying 97 firms out of 13.509 (0,72%), with the majority being medium-sized firms (45,36%), this data could foresee a trend for these firms engage in collaboration strategies involving more than one partner, however it is still an irrelevant practise.

Table 6 detail insights into innovation performance and structural characteristics of firms based on their collaboration strategies, such as coopetition, no collaboration and hybrid strategies (including clients, suppliers, universities, public research organizations and government).

Firms that engage in coopetition demonstrate significantly higher innovation rates, with 80,93% reporting product innovation and 85,57% engaged in process innovation. This contrasts starkly with firms that do not engage in coopetition, where innovation rates are markedly lower. Moreover, firms that coopete tend to have stronger internal R&D capabilities (76,29% compared to 16,43% for non-coopeting firms). This suggests that while they gain from external collaboration, they also place significant emphasis on strengthening their internal innovation efforts. Additionally, these firms attract a highly educated workforce (46,39%) and they are heavily represented in high-tech and knowledge-intensive industries (47,94%).

In contrast, firms that avoid any form of collaboration lag considerably in innovation. Only 28,01% report product innovation, and 49,23% have introduced process innovations. This isolation from external partnerships seems to limit their potential to innovate and grow. Furthermore, their internal R&D efforts are minimal (16,43%), and they struggle to attract skilled talent, with just 24,91% of their workforce holding higher education degrees. These firms are less likely to operate in high-tech sectors, with only 31,95% falling into this category, suggesting that they may not be positioned in industries where innovation is critical for survival or competitiveness.

Firms that pursue hybrid collaboration strategies - where firms collaborate not only with competitors but also with non-competitor partners - report similar rates of product and process innovation (80,83% and 85,49%), high investment in internal R&D, and attract highly educated talent at levels nearly indistinguishable from those that exclusively engage in coopetition. These results can imply that these firms who coopete are already engaged in

other types of collaboration and possible are trying to balance the intensity of coopetition with collaborative benefits from other stakeholders.

3.5. Descriptive statistics

Table 7 state the descriptive statistics, including frequency, minimum, maximum, mean, standard deviation and Pearson correlation matrix of the variables included in this study and described above.

Overviewing the statistics, 29% of the sample' firms introduced product innovation, while process innovation stands at 50%, indicating that process innovation is the most prominent type. The average of innovation performance is 10,92%, as the percentage of 2020 sales resulting from introduce new or significantly improved products.

Regarding collaboration types, the interaction with the government (20%) has higher engagement, followed by slightly higher level of cooperation with clients and/or suppliers (8%) and universities (6%). Additionally, 17% of the sample developed internal R&D activities.

The Pearson correlation matrix shows positive and significant correlation between all variables, except for firm size (SME) and technology intensity (INT_TECH) which are negative correlated. The innovation-related variables are highly correlated, especially between innovation performance (INNOV_PERFORMANCE) and product innovation (PRODUCT_INNOVATION).

If we look at correlation between innovation-related variables and collaboration, we see that collaboration with clients and suppliers is the highest correlated. On another instance, if we analyse the correlations between innovation-related variables and the firm structural characteristics, we conclude that the presence of internal R&D is the higher correlated.

Table 5: Types of collaboration and innovation performance by firm size

Firm Size		Cooperation with competitors		Cooperation with government (through public financial support)		Cooperation with public universities and public research institutes		Cooperation with clients or suppliers		Cooperation with competitors, government, universities, clients and suppliers		Product Innovation		Process Innovation	
	N	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Small	9 034	82	*42,27%*	1 509	*59,06%*	254	*35,33%*	382	*40,90%*	30	*30,93%*	2 070	*53,27%*	4 046	*60,20%*
Medium	3 682	75	*38,66%*	838	*32,80%*	323	*44,92%*	394	*42,18%*	44	*45,36%*	1 406	*36,18%*	2 132	*31,72%*
Large	793	37	*19,07%*	208	*8,14%*	142	*19,75%*	158	*16,92%*	23	*23,71%*	410	*10,55%*	543	*8,08%*
Total	**13 509**	**194**	***1,44%***	**2 555**	***18,91%***	**719**	***5,32%***	**934**	***6,91%***	**97**	***0,72%***	**3 886**	***28,77%***	**6 721**	***49,75%***

Table 6: Innovation performance and structural characteristics by coopetitive strategy

Cooperation with competitors		Product Innovation		Process Innovation		Internal R&D		Human Capital (>50% higher education)		Technological intensity (High-technology industry or knowledge intensive services)	
	N	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
No collaboration	13 315	3 729	*28,01%*	6 555	*49,23%*	2 187	*16,43%*	3 317	*24,91%*	4 254	*31,95%*
Coopetition	194	157	*80,93%*	166	*85,57%*	148	*76,29%*	90	*46,39%*	93	*47,94%*
Hybrid strategies	193	156	*80,83%*	165	*85,49%*	147	*76,17%*	90	*46,63%*	92	*47,67%*
Clients and suppliers	183	148	*80,87%*	158	*86,34%*	139	*75,96%*	85	*46,45%*	87	*47,54%*
Universities or public research org.	156	124	*79,49%*	131	*83,97%*	122	*78,21%*	71	*45,51%*	70	*44,87%*
Government	120	98	*81,67%*	100	*83,33%*	102	*85,00%*	59	*49,17%*	58	*48,33%*
Total	**13 509**	**3 886**	***28,77%***	**6 721**	***49,75%***	**2 335**	***17,28%***	**3 407**	***25,22%***	**4 347**	***32,18%***

Table 7: Descriptive statistics and Pearson correlation matrix

Variables	N	Min	Max	Mean	SD	Correlation											
						1	2	3	4	5	6	7	8	9	10	11	12
INNOV_PERFORMANCE (1)	13 509	0	100	10,92	25,272	1											
PRODUCT_INNOV (2)	13 509	0	1	0,29	0,453	,680**	1										
PROCESS_INNOV (3)	13 509	0	1	0,50	0,500	,328**	,471**	1									
COOP_COMP (4)	13 509	0	1	0,01	0,119	,104**	,139**	,086**	1								
COOP_SUPPLYCHAIN (5)	13 509	0	2	0,08	0,321	,181**	,281**	,198**	,679**	1							
COOP_UNIV (6)	13 509	0	2	0,06	0,289	,162**	,243**	,158**	,644**	,702**	1						
COOP_GOV (7)	13 509	0	2	0,20	0,420	,134**	,195**	,179**	,298**	,311**	,348**	1					
SME (8)	13 509	0	1	0,94	0,235	,067**	,195**	,148**	,077**	,161**	,169**	,093**	1				
I_D_INTER (9)	13 509	0	1	0,17	0,378	,279**	,446**	,302**	,188**	,376**	,394**	,231**	,277**	1			
HUMANCAPITAL (10)	13 509	1	7	3,76	2,029	,154**	,231**	,224**	,082**	,166**	,163**	,103**	,083**	,270**	1		
INT_TECH (11)	13 509	0	6	3,04	2,187	,101**	,116**	,093**	,039**	,064**	,062**	,031**	-,048**	,127**	,533**	1	
EXPORT (12)	13 509	0	100	16,95	29,250	,130**	,138**	,086**	,036**	,085**	,090**	,079**	,199**	,206**	,106**	,040**	1

**. The correlation is significant at the 0.01 level (2-tailed).

4. Discussion

Through the Multiple Linear Regression Model (model 1), we aim to understand the relationship between coopetition strategies and innovative performance, including control variables to account for other factors affecting innovation. We chose this econometric model due to the continuous nature of the dependent variable.

To assess whether the impact of coopetition on innovation differs depending on the size of the firm, it was included in model 2 an interaction term between each coopetition strategy and firm size.

Furthermore, to not only measure the impact of coopetition strategies on innovative performance but also on the firm's innovation activities, especially product and process innovation, we developed 8 models using logit regressions, where in models 3 and 4 were included all sample and the other 6 models were divided into micro, medium and large companies, to compare the impact of traditional and hybrid coopetition strategies on innovation and assess which strategy works best for each group.

To evaluate the models' validity and feasibility, we conducted some tests for investigating issues of heteroscedasticity and multicollinearity.

According to the results, there is no evidence of multicollinearity problems as the mean and maximum VIF are low and below 5 in all models, as we can see in Tables 8 and 9 that show the results of estimations of all the 10 models.

Through the Breusch–Pagan test, we conclude that the p-value is higher than the critic value, so there is no evidence for rejecting the null hypothesis of heteroscedasticity, we assume that the variance of errors is constant.

The R^2 suggests that 9,9% and 10% of the variance is explained by the included variables in models 1 and 2. The Nagelkerke R^2 on the logit regression models show that each model explain a mean of 25,7% of the variance. Summing up, the model present a reasonable goodness of fit. The -2LL indicates the adequacy of the estimated logit models.

4.1. Multiple linear regression models – the impact of coopetition strategies on innovation performance

Table 8 - Multiple linear regression models estimations

Variables	Model 1 INNOV_PERFORMANCE	Model 2 INNOV_PERFORMANCE
COOP_COMP	-2,389 (2,545)	-5,6 (3,671)
COOP_SUPPLYCHAIN	6,466 *** (1,019)	8,782 *** (1,385)
COOP_UNIV	-0,417 (1,102)	1,226 (1,543)
COOP_GOV	3,291 *** (0,532)	4,112 *** (0,656)
SME	-1,09 *** (0,368)	-0,25 (0,413)
I_D_INTER	14,193 *** (0,647)	14,18 *** (0,647)
HUMANCAPITAL	0,684 *** (0,125)	0,642 *** (0,125)
INT_TECH	0,392 *** (0,112)	0,402 *** (0,112)
EXPORT	0,064 *** (0,007)	0,065 *** (0,007)
INTERACT_SME_COMP		4,423 (3,467)
INTERACT_SME_SUPPLYCHAIN		-3,347 ** (1,463)
INTERACT_SME_UNIV		-1,258 (1,549)
INTERACT_SME_GOV		-1,788 ** (0,835)
Constant	2,916 *** (0,472)	2,699 *** (0,475)
Breusch– Pagan (p-value)	351,234	351,234
Mean VIF [Max]	1,638 (2,510)	3,191 (6,013)
Adj. R^2	0,099	0,010

***p < 0.01, **p < 0.05, *p < 0.1

The multiple linear regression models reveal essential patterns about the role of coopetition strategies in fostering innovation performance.

Traditional coopetition strategies, where firms collaborate with competitors, were expected to drive higher innovation performance (H1). However, the results indicated that this strategy did not have a significant impact on innovation performance. This outcome aligns with the findings in exploratory data analysis, where it was shown that only a small fraction of firms (1,44%) engaged in coopetition, with most firms favouring safer partnerships with non-competitors. The cultural and strategic hesitancy among Portuguese firms to collaborate with competitors likely contributes to this limited impact.

Several authors had proven before the non-significance of coopetition, such as Le Roy et al. (2016) where they find that collaboration with noncompetitors (customers and universities) is better for incremental innovation than coopetition, due to a non-significant impact. However, on the study of Fernandes et al. (2019), where the authors investigated also the impact of coopetition on innovative performance of Portuguese firms, they conclude that the strategy has a positive impact, contrasting with our results.

Cooperation in the supply chain (COOP_SUPPLYCHAIN) and with the government (COOP_GOV) is consistently positive and significant in both models, suggesting that collaborating with supply chain partners and government significantly enhances firms' innovative performance, with a higher impact of collaboration with clients and suppliers. On another hand, both models show that cooperation with universities (COOP_UNIV) do not show statistical significance, suggesting that this form of cooperation may not be as effective for innovation. These results underline the importance of firms not solely rely on coopetition but should also engage in broader collaborative networks to drive innovation. The strong positive influence of these collaborations underscores the value of diverse innovation ecosystems that include a variety of stakeholders, validating H3: "*Adding more collaboration partners to the coopetition strategy increase the effectiveness of their collaboration strategies on promoting higher innovative performance.*"

Model 1 suggests that firm size has a negative and statistically significant at the 1% level impact on innovative performance. Adding the intersection variables in model 2, firm size turns out as non-significant.

In model 2, it was added an interaction term that combine the effect of the firm size and coopetition (INTERACT_SME_COMP). The coefficient of the variable is positive and non-significant suggesting that the relationship between coopetition and innovation performance is similar regardless of firm size.

In our analysis, neither cooperation with competitors nor the interaction between cooperation with competitors and firm size showed a significant impact on innovation performance. This suggests that, within our sample, collaborating with competitors is not an effective strategy for enhancing innovation, regardless of whether the firm is an SME or a large enterprise. Firms may benefit from focusing their collaborative efforts on other types of partnerships that are more likely to drive innovation.

Facing the results, we include the variables INTERACT_SME_SUPPLYCHAIN, INTERACT_SME_UNIV and INTERACT_SME_GOV to assess how the effect of different types of cooperation on innovation performance varies by firm size.

Both coefficients of INTERACT_SME_SUPPLY_CHAIN (-3,347**) and INTERACT_SME_GOV (-1,788**) are negative and statistically significant and the variable INTERACT_SME_UNIV is negative and non-significant.

As a firm moves from micro to medium and from medium to large, the effect of government and clients/suppliers' collaboration (or collaboration with these partners and competitors) on innovation performance tends to be negative. This may suggest that the larger the firms, the less beneficial (or even detrimental) these forms of collaboration are to innovation performance, especially when a firm also coopetes.

This result corroborates the H2 "*The type of coopetition strategies distinctively influences the innovative performance of firms*" and H4a "*Coopetition strategies have a greater impact on the innovative performance of SMEs than in large firms*."

The hypothesis H4b: *"Hybrid coopetition strategies are more effective for SMEs*" is validated because, in fact, some hybrid strategies are more effective for small firms, even though hybrid coopetition involving universities revealed to be non-significant. Also, hypothesis H4c: "*Traditional coopetition strategies are more effective for large firms.*" is rejected because traditional coopetition is not effective for larger firms. Overall, the results show that the impact of coopetition strategies on innovation performance is not transversal to all firm sizes, confirming H4.

Regarding the control variables, the impact of internal R&D stands out with the higher positive and significant impact, suggesting a relevant relation between internal knowledge creation and innovation performance. However, all the dimensions, such as absorptive capacity, sector's technology intensity and exporting intensity have a positive and significant impact.

4.2. Logistic regression models – the impact of coopetition strategies on product and process innovation activities

Table 9 shows the estimations of logistics regressions from models 3 to 10, providing further insights into the effects of different coopetition strategies on the firms' innovative activities - product and process innovations - across different firm sizes (micro, medium, and large companies).

Models 3 and 4 explore the impact of coopetition on both product (PRODUCT_INNOV) and process innovation (PROCESS_INNOV). The results indicate that collaborating with competitors significantly enhances both product and process innovations, showing positive and significant coefficients, with a higher impact on product innovation. For example, in model 1, companies that collaborated with competitors have an approximately 9,83 ($e^{2,286}$) times greater chance of innovating in a product compared to companies that did not collaborate with competitors.

This result confirm that firms that engaged in coopetition tended to be more committed with innovation activities, with 80,93% and 85,57% of coopetition-engaged firms involved in product and process innovation activities, compared to only 28,01% and 49,23% of firms not engaging in coopetition.

Analysing the firm size in models 3 and 4, we expect that this variable will have an impact on innovation activities, since the coefficients are significant and the larger the firm, the greater the chance of developing product and process innovations, with a more noticeable effect on product innovation.

In terms of collaborating with external partners, cooperation with clients and suppliers (COOP_SUPPLYCHAIN) is a key factor for innovation, with significant and positive coefficients for both product and process innovation. Cooperation with government (COOP_GOV) also enhances the likelihood of occurring innovation with a less pronounced impact, particularly in large firms which becomes non-significant, indicating that these

collaborations may be more challenging or less effective in larger firms. These results are aligned with the studies of Estrada et al. (2015) and Le Roy et al. (2016), in which collaboration with customers and suppliers and with the government have a positive significant effect on firm's innovation performance.

Collaborating with universities (COOP_UNIV), in our general models, does not seem to have a relevant impact for both product and process innovation. Analysing the size groups, micro companies who collaborate with universities seems to have a negative impact on propensity to innovate, with a significant and negative but low coefficient. On the other hand, for product innovation in large companies, the coefficient is positive and significant.

This result aligns with the literature, which suggests that SMEs often rely more on external collaborations to compensate for their internal limitations in terms of resources and innovation capabilities (Morris et al. 2007; Gnyawali and Park, 2009).

When we add the coopetition dimension on the collaboration variables, we observe that the three hybrid strategies do not show statistical significance for product innovation. However, in the process innovation model, both coefficient of variables COOP_UNIV and COOP_GOV are negative and significant and COOP_SUPPLYCHAIN is positive and significant.

These findings highlight the importance of specifying the innovation type, once they have different determinants. As for H3: "*Adding more collaboration partners to the coopetition strategy increase the effectiveness of their collaboration strategies on promoting higher innovative performance*." the results are inconclusive, it depends on the innovation type and the specific coopetition strategy. With our sample, only if the collaboration partner is a client or supplier, will there be an increase in coopetition strategy efficiency to promote process innovation activities.

Overall, these results reject H1: "*Coopetition strategies have a positive impact on firms' propensity to innovate and, consequently, in their innovative performance.",* although traditional coopetition increase both chances of product and process innovation, not all strategies behave the same way, once hybrid strategies including universities or government decreases the propensity to innovate and hybrid strategies involving supply chain partners increase the chance of innovate.

Positive results for traditional coopetition are aligned with several authors (Fernandes et al., 2019; Le Roy et al., 2016; Estrada et al., 2015; Yang, 2022; Bouncken et al., 2018; Park et al.,

2014; Barrales-Moli et al., 2022; Vanyushyn et al., 2017; Santos et al., 2021), that also had shown a positive impact of coopetition on innovation. For instance, Fernandes et al. (2019), who also focused their study on Portuguese firms, distributed by sectors, had showed that coopetition exhibits a significant impact especially on product innovation activities.

Comparing with the results of the multiple linear regression models, where there is evidence of lack of statistical significance for traditional coopetition strategies, suggesting that simply coopeting may not be sufficient to enhance overall innovation outcomes, this could imply that while coopetition might help firms engage in innovation activities, it does not necessarily translate into a higher level of performance or success in innovation.

H2: "*The type of coopetition strategy distinctively influences the innovative performance of firms and their propensity to innovate.*" is supported, as there is a variation in impact depending on the type of coopetition. Although it seems that traditional coopetition contributes more to innovation activities then hybrid strategies, opposing Nieto and Santamaria (2007) who defended that the diversity of partners favours innovation.

Analysing the effect of separate the sample according to firm size, the estimations for micro and medium-sized companies, in models 5 and 7, show that coopeting increase propensity to engage in product activities, however it does not have an impact in the probability of SMEs innovating in processes. Additionally, we reject H4b: "*Hybrid coopetition strategies are more effective for SMEs.*", once SMEs don't benefit more from hybrid approaches, as they're non-significant.

For large firms (models 9 and 10), collaborating with competitors, through traditional or hybrid strategies, do not increase the propensity of these firms innovate (product or process). For this reason, we reject H4c: "*Traditional coopetition strategies are more effective for large firms."* and validate H4a: "*Coopetition strategies have a greater impact on the innovative performance of SMEs than in large firms.*".

However, additional research may be required to further reinforce the present results given that despite their econometric validity, estimations should be interpreted with caution, given the small sample size of large firms that engaged in coopetition with competitors (37 out of 793). The risk of overfitting or inflated results due to the small number of observations could be present, potentially leading to biases in the estimated effects.

These results, however, prove that the impact of coopetition strategies on SMEs and large firms are different (Bouncken et al., 2018), validating H4: "*The impact that coopetition strategies have on innovation propensity and performance is not transversal to all firm sizes*.".

Regarding the control variables, we can highlight the importance of knowledge creation and absorptive capacity dimensions, whereby the internal R&D activities (I_D_INTER) and higher levels of human capital (HUMANCAPITAL) are consistently significant across these models, demonstrating that firms with greater internal R&D efforts and a more educated workforce are more likely to innovate.

If we look into sectors' technology intensity, the model 1 suggests that if the firm is part of a medium-high technology sector or knowledge-intensive services has a higher propensity of developing product innovation activities. Focusing on process innovation the same happens to knowledge-intensive services sectors. Comparing the results of models separated by firm size, the results are consistent except for medium-sized firms, where firms from low-technology manufacturing sectors have also a high chance of innovating in products and firms from less knowledge-intensive service sectors are more likely to develop process innovations.

Table 9 - Logit models estimations

Variables		Model 3 PRODUCT_ INNOV	Model 4 PROCESS_ INNOV	Model 5 PRODUCT_INNOV (Micro companies)	Model 6 PROCESS_INNOV (Micro companies)	Model 7 PRODUCT_INNOV (Medium companies)	Model 8 PROCESS_INNOV (Medium companies)	Model 9 PRODUCT_INNOV (Large companies)	Model 10 PROCESS_INNOV (Large companies)
COOP_COMP		2,286 ** (0,944)	1,56 * (0,924)	2,423 * (1,385)	2,433 (1,564)	2,472 * (1,401)	1,255 (1,466)	21,162 (46506,184)	37,423 (41740,942)
COOP_ SUPPLY CHAIN	Collaborates	1,139 *** (0,108)	1,267 *** (0,132)	1,312 *** (0,155)	1,424 *** (0,191)	0,909 *** (0,165)	1,068 *** (0,207)	1,14 *** (0,363)	1,091 *** (0,421)
	Collaborates and coopetes	0,334 (0,881)	1,3 * (0,774)	-0,021 (1,272)	0,809 (1,208)	1,511 (1,622)	21,533 (10883,227)	-0,339 (40953,493)	-18,784 (40192,991)
COOP_ UNIV	Collaborates	-0,01 (0,131)	-0,154 (0,147)	-0,449 ** (0,205)	-0,594 *** (0,221)	0,135 (0,191)	0,228 (0,231)	1,054 ** (0,417)	0,316 (0,442)
	Collaborates and coopetes	-0,876 (0,577)	-1,334 * (0,711)	-0,719 (0,692)	-1,716 (1,126)	-2,341 (1,546)	-21,3 (10883,227)	0,228 (21343,727)	2,421 (1,622)
COOP_GOV	Collaborates	0,48 *** (0,055)	0,617 *** (0,051)	0,577 *** (0,07)	0,652 *** (0,063)	0,431 *** (0,096)	0,606 *** (0,097)	-0,137 (0,221)	0,227 (0,22)
	Collaborates and coopetes	-0,547 (0,417)	-0,927 ** (0,471)	-0,742 (0,568)	-0,752 (0,682)	-0,772 (0,741)	-1,199 (0,865)	-0,309 (14488,464)	-19,836 (11261,877)
SME	50 to 249 employees	0,244 *** (0,051)	0,158 *** (0,045)						
	250 or more employees	0,467 *** (0,093)	0,339 *** (0,089)						
I_D_INTER		1,776 *** (0,061)	1,318 *** (0,066)	2,08 *** (0,089)	1,486 *** (0,098)	1,496 *** (0,095)	1,187 *** (0,104)	1,384 *** (0,201)	1,079 *** (0,216)
HUMAN CAPITAL	>=1% a <5%	0,563 *** (0,093)	0,626 *** (0,066)	0,531 *** (0,102)	0,642 *** (0,072)	0,983 *** (0,29)	0,69 *** (0,193)	0,281 (0,97)	1,113 (0,875)
	>=5% a <10%	0,722 *** (0,104)	0,858 *** (0,079)	0,751 *** (0,124)	0,85 *** (0,094)	1,171 *** (0,296)	1,026 *** (0,202)	0,211 (0,976)	1,32 (0,88)
	>=10% a <25%	0,939 *** (0,099)	1,033 *** (0,075)	0,695 *** (0,118)	0,859 *** (0,089)	1,61 *** (0,291)	1,385 *** (0,199)	0,939 (0,968)	1,892 ** (0,878)

	>=25% a <50%	0,915 *** (0,104)	0,994 *** (0,081)	0,816 *** (0,121)	0,981 *** (0,094)	1,519 *** (0,301)	1,143 *** (0,212)	0,412 (0,981)	1,45 (0,887)
	>=50% a <75%	1,007 *** (0,108)	1,125 *** (0,085)	0,893 *** (0,123)	1,159 *** (0,097)	1,684 *** (0,308)	1,202 *** (0,222)	0,399 (0,995)	1,267 (0,903)
	>=75% a 100%	1,252 *** (0,106)	1,185 *** (0,084)	1,089 *** (0,119)	1,217 *** (0,094)	2,014 *** (0,31)	1,152 *** (0,225)	0,723 (0,992)	1,625 * (0,907)
INT_TECH	low-technology manufacturing firms	0,818 *** (0,106)	0,135 (0,084)	0,732 *** (0,154)	0,105 (0,112)	1,037 *** (0,165)	0,255 * (0,142)	0,188 (0,404)	-0,114 (0,386)
	less knowledge-intensive services	0,749 *** (0,084)	0,353 *** (0,061)	0,79 *** (0,11)	0,333 *** (0,074)	0,657 *** (0,149)	0,4 *** (0,121)	0,571 * (0,303)	0,368 (0,276)
	medium-low-technology	0,751 *** (0,115)	0,151 (0,094)	0,753 *** (0,161)	0,22 * (0,121)	0,779 *** (0,182)	0,13 (0,162)	0,969 * (0,509)	-0,199 (0,464)
	medium-high-technology	1,142 *** (0,156)	0,251 * (0,142)	1,011 *** (0,235)	0,133 (0,2)	1,261 *** (0,249)	0,391 (0,243)	1,103 ** (0,468)	0,287 (0,458)
	knowledge-intensive services	1,061 *** (0,283)	0,828 *** (0,304)	1,064 ** (0,445)	0,793 * (0,44)	1,094 *** (0,399)	0,715 (0,438)	1,691 (1,126)	19,774 (11870,104)
	high-technology	0,562 *** (0,092)	0,121 * (0,07)	0,607 *** (0,118)	0,051 (0,083)	0,467 *** (0,165)	0,299 ** (0,141)	0,461 (0,343)	0,345 (0,316)
EXPORT		0,002 ** (0,001)	0,000 (0,001)	0,002 ** (0,001)	0,001 (0,001)	-0,001 (0,001)	0,000 (0,001)	0,006 ** (0,003)	0,001 (0,003)
Constant		-3,016 *** (0,106)	-1,443 *** (0,072)	-3,018 *** (0,126)	-1,423 *** (0,081)	-3,17 *** (0,303)	-1,472 *** (0,201)	-2,044 ** (0,981)	-1,572 * (0,886)
Breusch–Pagan (p-value)		351,234	351,234	225,850	379,428	110,460	312,970	74,542	103,883
Mean VIF [Max]		1,638 (2,510)	1,638 (2,510)	1,619 (2,250)	1,619 (2,250)	1,674 (2,461)	1,674 (2,461)	1,938 (3,441)	1,938 (3,441)
-2 Log Likelihood		3217,917 (0,000)	2192,916 (0,000)	6,928 (0,544)	11,513 (0,174)	10,328 (0,243)	18,140 (0,020)	3,948 (0,862)	12,178 (0,143)
Nagelkerke R^2		0,303	0,200	0,246	0,166	0,303	0,207	0,411	0,221
N		13 509	13 509	9 034	9 034	3 682	3 682	793	793

***p < 0.01, **p < 0.05, *p < 0.1

5. Conclusion

Theoretical and empirical findings

This study aimed to investigate the impact of coopetition strategies—both traditional and hybrid—on the innovative performance and innovation activities of Portuguese firms, with special emphasis on comparing the results for small and medium-sized enterprises (SMEs) and large firms.

The research succeed to answer the investigation questions regarding how these strategies influence innovative capacity, whether firm size plays a significant role in differentiate coopetition strategies and assessing if adding more collaborative partners to a coopetitive relationships increase the effectiveness of the strategy on promoting innovation. To support our theoretical fundamentals, we employ multiple linear regression and logistic regression models, using the database retrieved from CIS2020.

The results provided by the models support the theoretical framework with unexpected conclusions, such as the traditional coopetition strategies are more beneficial for SMEs, particularly in fostering product innovation, opposing the literature statement about collaborative networks and its benefits for SMEs. However, while coopetition might help firms engage in innovation activities, it does not necessarily translate into a higher level of performance or success in innovation.

These findings align with the hypothesis that SMEs, often constrained by limited resources (Corbo et al., 2022; Morris et al. 2007), can leverage coopetition to enhance their innovation capabilities. On the other hand, the expected benefits of these strategies for large firms were not evident, suggesting that traditional coopetition might be less effective for larger enterprises, potentially due to their already established market positions and resource bases.

Hybrid strategies, which involve collaboration with both competitors and non-competitors, showed mixed results. While they appeared to have some positive effects on process innovation, especially hybrid strategies with clients/suppliers and competitors, their overall impact was less consistent. This indicates that the effectiveness of hybrid coopetition strategies may be context-dependent, requiring careful consideration of the specific partners and goals involved.

Collaboration with non-competitor partner was revealed as important for innovation, especially collaboration with clients, suppliers and government, however it does not seem

that firm size changes significantly the likelihood of innovating. The firms should then engage in collaborative networks with a variety of partners to drive innovation (Nieto and Santamaria, 2007; Bengstsson and Kock, 2000).

Implications and consequences

The findings of this research have significant implications for both theory and practice. For SMEs, the results highlights the importance of engaging in coopetition as a strategic approach to overcoming resource limitations and driving innovation. However, for large firms, the lack of significant impact suggests a need to explore alternative or more nuanced forms of cooperation that can better complement their existing capabilities.

From a policy perspective, the study suggests that public policies should consider the distinct needs and characteristics of SMEs and large firms when promoting coopetition as a strategy for innovation. Tailored support measures could help maximize the benefits of coopetition, particularly for SMEs that stand to gain the most from such strategies.

Additionally, current policy is blind to the type of innovation that is promoting, whether it is innovation input, such as firms' activities, or output innovation related to performance. The results show that even if firms use coopetition strategies to enhance innovation activities, which have an overall positive effect, they fail to capture its value, by not being able to translate those activities in innovation performance. So, instead of investing in upstream innovation activities, public policy should invest in measures to support firms downstream on innovation chain.

Research gaps and future directions

Despite the contributions of this research, several gaps remain. One notable limitation is the focus on the Portuguese context, which may limit the generalizability of the findings to other countries. Additionally, the study did not extensively explore the long-term effects of coopetition on innovation performance.

Future research could address these limitations by replicating the study in different countries and by conducting longitudinal analyses to better understand the sustained impact of coopetition strategies over time. Furthermore, it would be valuable to investigate the role of sector-specific factors and how they might influence the effectiveness of different coopetition strategies.

Another area for future exploration is the potential for hybrid strategies to be more effectively tailored to the needs of larger firms. Understanding how these strategies can be optimized to leverage the strengths of diverse partners could provide new insights into how large firms can enhance their innovation performance through coopetition.

The inconsistencies between the two models suggest that the relationship between coopetition strategies and innovation is complex and multifaceted. It highlights the importance of considering both the likelihood of engaging in innovation activities and the extent of innovation performance when evaluating the effectiveness of such strategies. Future research could explore these differences further, possibly using additional methods or models to triangulate the findings.

Contributions

This study contributes to the existing literature by providing empirical evidence on the differentiated impact of traditional and hybrid coopetition strategies on the innovation performance of firms, with a particular focus on the role of firm size. The findings emphasize the importance of considering firm-specific characteristics when developing and implementing coopetition strategies, offering valuable insights for both academics and practitioners.

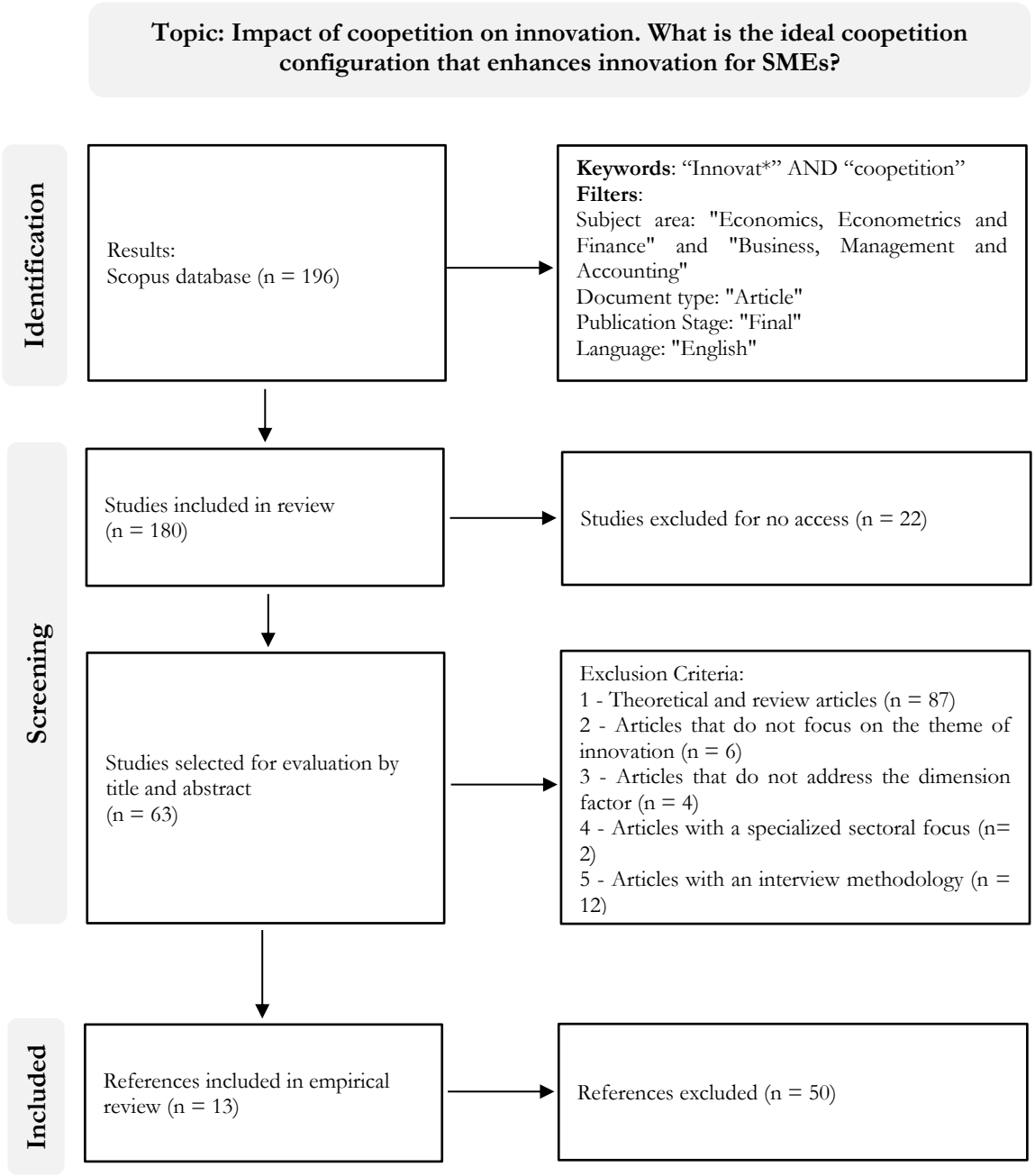
In conclusion, while traditional coopetition strategies prove advantageous for SMEs, large firms may need to explore more complex or diversified forms of collaboration to achieve similar innovation outcomes. The study underscores the need for policies that support the nuanced application of coopetition strategies across different firm sizes and contexts.

6. Appendix I

To develop the literature review of prior empirical studies we adopted the systematic review tool Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA).

The literature selection for our review was applied based on the following stages: identify the study focus topic; select the database used to identify studies; specify the strategy implied in the search including the filters used; identify eligibility criteria for studies; analyse the remain studies based on the title, abstract; create a synthesis of all studies selected and relevant.

Below it is illustrated the PRISMA diagram with the summary of the systematic method used.



7. Appendix II

The following table shows the aggregations of manufacturing based on NACE Rev. 2 used by Eurostat according to technological intensity: high technology, medium-high-technology, medium-low-technology; low-technology; knowledge intensive services and less knowledge-intensive services. The non-cited sector are considered unclassified.

NACE Rev. 2 codes	Technological intensity category
21	High technology
26	High technology
20	Medium-high-technology
27	Medium-high-technology
28	Medium-high-technology
29	Medium-high-technology
30	Medium-high-technology
19	Medium-low- technology
22	Medium-low- technology
23	Medium-low- technology
24	Medium-low- technology
25	Medium-low- technology
33	Medium-low- technology
10	Low technology
11	Low technology
12	Low technology
13	Low technology
14	Low technology
15	Low technology
16	Low technology
17	Low technology
18	Low technology
31	Low technology
32	Low technology
50	Knowledge intensive services
51	Knowledge intensive services
69	Knowledge intensive services
70	Knowledge intensive services
71	Knowledge intensive services
73	Knowledge intensive services
74	Knowledge intensive services
78	Knowledge intensive services
80	Knowledge intensive services
58	Knowledge intensive services
59	Knowledge intensive services
60	Knowledge intensive services
61	Knowledge intensive services
62	Knowledge intensive services
63	Knowledge intensive services
64	Knowledge intensive services
65	Knowledge intensive services
66	Knowledge intensive services
72	Knowledge intensive services
75	Knowledge intensive services
84	Knowledge intensive services
85	Knowledge intensive services
86	Knowledge intensive services
87	Knowledge intensive services
88	Knowledge intensive services
89	Knowledge intensive services
90	Knowledge intensive services
91	Knowledge intensive services
92	Knowledge intensive services
93	Knowledge intensive services
45	Less knowledge-intensive services
46	Less knowledge-intensive services
47	Less knowledge-intensive services
49	Less knowledge-intensive services
52	Less knowledge-intensive services
53	Less knowledge-intensive services
55	Less knowledge-intensive services
56	Less knowledge-intensive services
68	Less knowledge-intensive services
77	Less knowledge-intensive services
79	Less knowledge-intensive services
81	Less knowledge-intensive services
82	Less knowledge-intensive services
94	Less knowledge-intensive services
95	Less knowledge-intensive services
96	Less knowledge-intensive services
97	Less knowledge-intensive services
98	Less knowledge-intensive services
99	Less knowledge-intensive services

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