U.PORTO

MASTER
ECONOMICS AND BUSINESS ADMINISTRATION

The Role of Digital Transformation in Foresting Innovation Through Coopetition

Sofia da Cruz Félix

M

2025

FACULDADE DE **ECONOMIA**

U.PORTO

FEP FACULDADE DE ECONOMIA
UNIVERSIDADE DO PORTO

The Role of Digital Transformation in Foresting Innovation Through Coopetition

Sofia da Cruz Félix

Dissertation

Master's in Economics and Business Administration

Supervised by
Joana Costa
Manuel Duarte Rocha

2025

Acknowledgements

I am writing to express my sincere gratitude to all those who contributed to the completion of this dissertation.

First and foremost, I extend my deepest thanks to my supervisor, Professor Joana Costa, for her invaluable guidance, insightful feedback, and unwavering support throughout every stage of this research.

I am also grateful to the *Direção-Geral de Estatísticas da Educação e Ciência* (DGEEC) and the *Instituto Nacional de Estatística* (INE) for providing access to the Community Innovation Survey data, which formed the empirical basis of this study.

A special word of appreciation goes to my colleagues, classmates, and friends for their encouragement, insightful discussions, and for making this academic journey more rewarding.

Lastly, I wish to thank my family for their patience, understanding, and constant encouragement. Without their support, this achievement would not have been possible.

Abstract

This dissertation explores the role of digital transformation in fostering coopetition—a strategic approach where firms simultaneously compete and collaborate. In the context of accelerating digitalisation and growing adoption of technologies such as Artificial Intelligence (AI), big data, and cloud platforms, the study investigates how digital tools enable firms, particularly Small and Medium Enterprises (SMEs) and large enterprises, to engage in innovation-driven collaborative networks while maintaining competitive positioning.

By applying the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) methodology, a systematic literature review was conducted and structured into four thematic areas: (1) coopetition and innovation strategies in SMEs, (2) coopetition and innovation strategies in large enterprises, (3) challenges and policy implications for SMEs, and (4) tensions and regulatory concerns in large-scale coopetition. The empirical analysis reveals that while SMEs engage in coopetition to overcome resource limitations, while large enterprises leverage it strategically to set technological standards and expand digital ecosystems.

The study adopts a quantitative empirical approach using data from the Community Innovation Survey and builds on econometric models validated in recent literature. Expected outcomes indicate that digital transformation enhances coopetition by reducing collaboration costs, enabling data sharing, and improving access to innovation platforms. However, it also raises significant challenges in intellectual property management, market concentration, and regulatory oversight.

Findings show that research and development (R&D) and marketing coopetition improve innovation performance, while production-focused collaborations mainly enhance overall firm performance. SMEs gain more from marketing alliances, helping them overcome resource constraints, whereas large firms rely on R&D coopetition to consolidate technological leadership and set industry standards. These insights suggest that policymakers should design tailored digital policies to foster SME inclusion, while regulators must ensure platform-based coopetition does not lead to monopolistic practices.

Keywords: Digital Transformation; Coopetition; Innovation Strategies; SMEs; Public Policy; PRISMA

Resumo

Esta dissertação analisa o papel da transformação digital na promoção da coopetição — uma estratégia em que as empresas competem e cooperam simultaneamente. Num contexto de rápida digitalização e crescente adoção de tecnologias como AI, *big data* e plataformas digitais, o estudo investiga de que forma as ferramentas digitais permitem às Pequenas e Médias Empresas (PMEs) e às grandes empresas integrarem redes colaborativas orientadas para a inovação, mantendo a diferenciação competitiva.

Recorrendo ao método *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA), foi realizada uma revisão sistemática da literatura, estruturada em quatro áreas temáticas: (1) estratégias de coopetição e inovação em PMEs, (2) estratégias de coopetição e inovação em grandes empresas, (3) desafios e implicações políticas para PMEs e (4) tensões e preocupações regulatórias na coopetição entre grandes empresas. A revisão empírica demonstra que, enquanto as PMEs recorrem à coopetição para colmatar limitações de recursos, as grandes empresas utilizam-na estrategicamente para definir padrões tecnológicos e expandir ecossistemas digitais.

O estudo segue uma abordagem empírica quantitativa com base nos Inquéritos Comunitários à Inovação, apoiando-se em modelos econométricos validados na literatura recente. Os resultados esperados indicam que a transformação digital reforça a coopetição ao reduzir custos de colaboração, facilitar o acesso a dados e potenciar plataformas de inovação. Contudo, também levanta desafios significativos ao nível da gestão da propriedade intelectual, da concentração de mercado e da necessidade de regulação.

Os resultados demonstram que a coopetição em investigação e desenvolvimento (R&D) e marketing melhora o desempenho inovador, enquanto as colaborações na produção reforçam sobretudo o desempenho global da empresa. As PMEs beneficiam mais das alianças em marketing, superando limitações de recursos, enquanto as grandes empresas utilizam a coopetição em I&D para consolidar a liderança tecnológica e definir padrões industriais. Estes achados sugerem que os decisores devem adotar políticas digitais diferenciadas para apoiar a inclusão das PMEs e que os reguladores devem garantir que a coopetição em plataformas não conduz a práticas monopolísticas.

Palavras-Chave: Transformação Digital; Coopetição; Estratégias de Inovação; PMEs; Políticas Públicas; PRISMA

Table of Contents

List of Graphics

List of Tables

List of Acronyms

AC – Absorptive Capacity

AI – Artificial Intelligence

CIS – Community Innovation Survey

DGEEC – *Direção-Geral de Estatísticas da Educação e Ciência*

EO – Entrepreneurial Orientation

EU – European Union

GPTs – General Purpose Technologies

ICT – Information and Communication Technologies.

INE – *Instituto Nacional de Estatística (Statistics Portugal)*

IP – Intellectual Property

IT – Information Technology

OLS – Ordinary Least Squares

PMEs – *Pequenas e Médias Empresas*

PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses

R&D – Research and Development

RBV – Resource-Based View

SEM – Structural Equation Modelling

SMEs – Small and Medium Enterprises

SRT – Shared Resource Theory

SRT – Shared Resource Theory

US – United States

VIFs – Variance Inflation Factors

VRIN – Valuable, Rare, Inimitable, and Non-substitutable

Chapter 1. Introduction

In the era of rapid technological advancement, digital transformation has emerged as a fundamental driver of organisational change, reshaping how firms operate, compete, and collaborate. One of the most notable strategic shifts in this landscape is coopetition—the simultaneous cooperation and competition between firms. Traditionally, firms engaged in competitive rivalry or strategic alliances, but the digital economy has blurred these boundaries, encouraging companies to collaborate with competitors while maintaining market differentiation (Reischauer & Hoffmann, 2023). This shift is particularly relevant today, as investments in Artificial Intelligence (AI), big data, and platform-based business models redefine how firms manage information, innovation, and value creation.

Understanding the intersection between digital transformation and coopetition is crucial in the current economic climate. Digital transformation refers to the broader integration of digital technologies — such as cloud computing, big data analytics, and platform-based ecosystems — which enable firms to leverage shared infrastructures, collaborate on technological advancements, and access broader market opportunities while maintaining competitive positioning (Melo et al., 2023). In contrast, artificial intelligence (AI) represents a specific technological domain within this transformation. The accelerated adoption of AI and algorithm-driven decision-making introduces new complexities, requiring firms to strategically balance collaboration with competitors and the protection of proprietary knowledge (Bouwman et al., 2019). Distinguishing between these two dimensions is essential: digital transformation provides the structural foundations for coopetition, while AI intensifies both its opportunities and its challenges.

This study explores the role of digital transformation in fostering coopetition strategies, addressing how firms, particularly Small and Medium Enterprises (SMEs) and large companies, engage in collaborative networks facilitated by digital technologies. The relevance of firm size lies in the fact that SMEs and large enterprises face markedly different resource conditions and strategic constraints. SMEs often struggle with limited financial capacity, technological infrastructure, and human capital, making coopetition a critical mechanism to access complementary assets and reduce innovation risks (Navío-Marco et al., 2021). Large firms, by contrast, possess stronger internal R&D pipelines and absorptive capacity, allowing

them to use coopetition more strategically — not only to enhance innovation but also to shape technological standards and consolidate ecosystem leadership (Heikkilä et al., 2023). By analysing these contrasts, the research seeks to understand how digitalisation influences traditional coopetition models and the emergence of hybrid strategies, where firms integrate digital tools to balance collaboration with competitors while sustaining competitive differentiation. Furthermore, it examines how digital transformation promotes strategic networking, enhances firm agility, and redefines market competition dynamics (Zhou & Li, 2020).

To achieve this, the study employs an empirical analysis using econometric models, leveraging data from Community Innovation Surveys to assess the impact of digitalisation on coopetition strategies. The methodology follows approaches from previous studies (e.g., Ramos et al., 2022; Clemente-Almendros et al., 2024), ensuring alignment with established research frameworks. By examining digital adoption trends across firms of different sizes and sectors, the study identifies key determinants shaping collaborative strategies in a technology-driven economy.

Based on existing literature, expected results suggest that digital transformation enhances firms' ability to engage in coopetition by lowering collaboration costs, increasing data accessibility, and fostering open innovation ecosystems (Reischauer & Hoffmann, 2023). These findings are particularly relevant in the Portuguese context, where public policies such as *Portugal Digital*[1] aim to reduce technological disparities between SMEs and larger enterprises and to accelerate the country's digital transition (Bouwman et al., 2019). Such initiatives highlight the importance of aligning national strategies with firm-level digital adoption, ensuring that coopetition contributes not only to innovation outcomes but also to inclusive and sustainable economic growth. Firms that leverage digital tools for coopetition are therefore expected to achieve improved market performance, higher innovation outputs, and greater operational efficiency.

The conclusions drawn from this research have significant implications for public policy and business strategy. As AI and digital platforms become more pervasive, policymakers must develop regulatory frameworks that support inclusive and sustainable digital ecosystems,

[1] Further details on the Portugal Digital strategy are available at: https://portugaldigital.gov.pt/

ensuring that digital transformation benefits firms across industries. These expectations are consistent with prior evidence showing that coopetition fosters innovation outcomes when embedded in strong institutional and regulatory frameworks (Reischauer & Hoffmann, 2023; Mariani & Belitski, 2023). Similarly, studies on SMEs emphasise that policy intervention is essential to bridge digital capability gaps and prevent value appropriation by larger competitors (Navío-Marco et al., 2021; Liu et al., 2024). At the firm level, our findings are aligned with Ramos et al. (2022), who demonstrated that digital tools enhance open innovation networks, while also extending insights into how coopetition can drive resilience and competitiveness in platform-based markets.

This study therefore contributes to both academic and practical discussions. Academically, it strengthens the understanding of how digital transformation reshapes coopetition dynamics, integrating the Resource-Based View (RBV) and Shared Resource Theory (SRT) with empirical evidence from Portugal. Practically, it provides actionable insights for policymakers, by clarifying how targeted digital adoption programmes and regulatory safeguards can promote fairer innovation ecosystems, and for business leaders, by showing how coopetition strategies can be structured to improve resource efficiency, innovation capacity, and market positioning in an increasingly digital economy. Examining how digital technologies facilitate new collaborative business models offers a foundation for anticipating the evolution of coopetition in digitally driven markets.

Chapter 2. Literature Review

2.1 Introduction to Digital Transformation and Coopetition

The rapid advancement of digital transformation is reshaping how firms compete and collaborate, fundamentally altering business models and market dynamics. The integration of technologies such as AI, big data analytics, and cloud-based platforms enables firms to optimise operations and co-create value within interconnected digital ecosystems (Rogers, 2016).

This shift has intensified competition while simultaneously fostering new forms of collaboration, notably coopetition — the strategic interplay where firms compete and cooperate to enhance innovation and market positioning (Reischauer & Hoffmann, 2023). Traditionally seen as opposing forces, competition and collaboration increasingly coexist in digital markets characterised by real-time data exchange and cross-industry partnerships.

For SMEs, coopetition provides a critical mechanism to overcome resource constraints by accessing shared digital infrastructures, emerging technologies, and specialised knowledge (Bouwman et al., 2019). Large firms, in turn, use coopetition to set industry standards and expand technological ecosystems, especially in fields like AI and platform services (Heikkilä et al., 2023; Riillo et al., 2024).

However, digital coopetition also raises challenges related to intellectual property, data governance, and trust in shared networks (Melo et al., 2023). Firms must manage risks of knowledge leakage and competitive misalignment while ensuring fair market dynamics.

Understanding the relationship between digital transformation and coopetition is therefore essential for developing strategies and policies that foster collaborative innovation while preserving competitive advantage (Reischauer & Hoffmann, 2023; Mariani & Belitski, 2023). The following sections examine the theoretical roots, empirical evidence, and policy implications of digital coopetition in a globalised, technology-driven context.

2.2 Conceptual and Methodological Foundations[2]

2.2.1 Methodological Approach and PRISMA Selection Process

To ensure methodological rigour, this study applied the **PRISMA** (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach, widely recognised for enhancing transparency and replicability in systematic literature reviews in management and innovation research. The complete process, including screening and exclusion criteria, is documented in **Annex 1** (PRISMA flow diagram).

Search Strategy

The literature search was conducted in **Scopus** (February 2025) using the string: *"coopetition" AND "innovation"*.

The following filters were applied:

- Subject area: *Business, Management and Accounting*; *Economics, Econometrics and Finance*
- Document type: *Article*
- Source type: *Journal*
- Language: *English*

The initial search returned **393 results**, reduced to **58 articles** after applying subject area filters. A manual screening process was then conducted, applying the following exclusion criteria:

- Removal of purely theoretical papers without empirical analysis.
- Elimination of studies that did not examine coopetition as a determinant of innovation.
- Exclusion of works based solely on perceptions without measurable variables.
- Removal of articles with restricted access or unavailable full texts.

[2] The PRISMA methodology (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) was followed in accordance with the official guidelines available at: http://prisma-statement.org.

- Filtering out studies with no direct link to digital transformation and coopetition.

After applying these criteria, **24 articles** were retained for in-depth analysis.

Thematic Classification

Following PRISMA standards, the selected articles were categorised into four thematic subgroups:

1. Coopetition and Innovation in SMEs
2. Coopetition and Innovation in Large Firms
3. Tensions and Policy Implications for SMEs
4. Tensions and Policy Implications for Large Firms

This classification enabled a structured synthesis of findings and facilitated cross-comparison between organisational contexts.

Following PRISMA standards, several articles were excluded due to lack of relevance — e.g., works focusing solely on sustainability or tourism without direct links to coopetition or digital transformation (see Annex 1 for full list).

Synthesis of Included Articles (*Annex 2 – PRISMA Analysis*)

The 24 included studies combined quantitative and qualitative methodologies, covering topics such as the impact of coopetition intensity on first-mover advantage (Mariani & Belitski, 2023), the role of coopetition in setting technological standards in General Purpose Technologies (Heikkilä et al., 2023), and the influence of regional innovation networks on SMEs (Berbegal-Mirabent et al., 2021). Overall, the findings converge on several points. Coopetition is consistently identified as a catalyst for both organisational and business model innovation (Mariani & Belitski, 2023). At the same time, significant differences emerge in its adoption between SMEs and large enterprises, reflecting variations in resources and strategic orientation (Heikkilä et al., 2023; Berbegal-Mirabent et al., 2021). The literature also highlights substantial risks related to power asymmetries and unequal value appropriation, which may undermine the benefits of collaborative strategies (Reischauer & Hoffmann, 2023). Finally, multiple studies underline the importance of policy frameworks tailored to

firm size and technological context, as these are essential to ensure that coopetition contributes to fair and sustainable innovation outcomes (Bouwman et al., 2019; Liu et al., 2024).

The rigorous application of the PRISMA method ensured that only robust, relevant empirical evidence informed this study, thereby strengthening both its academic validity and its practical policy relevance.

2.2.2 Resource-Based View (RBV) and Shared Resource Theory (SRT)

The Resource-Based View (RBV) explains how firms achieve sustainable competitive advantage by leveraging VRIN resources (valuable, rare, inimitable, non-substitutable) (Barney, 1991). For SMEs, limited internal resources often necessitate external partnerships. The Shared Resource Theory (SRT) extends this by highlighting how firms share complementary capabilities to boost innovation while preserving autonomy (Chesbrough, 2003).

The choice of RBV and SRT as the theoretical foundation of this study derives from their ability to capture the dual nature of coopetition in the digital era. RBV is particularly relevant for analysing the heterogeneity of resources between SMEs and large firms, which explains why coopetition emerges as a mechanism to compensate for resource gaps. SRT, on the other hand, provides a complementary perspective by emphasising collaborative resource pooling and joint value creation, which are central to understanding digital platforms and innovation ecosystems.

Digital transformation amplifies the relevance of both theories by enabling resource exchange through AI, big data, and digital platforms (Rogers, 2016). This creates new coopetition dynamics: SMEs use coopetition to overcome scale constraints and co-create innovations, while large firms adopt coopetition to set industry standards and integrate emerging technologies (Reischauer & Hoffmann, 2023). However, digital coopetition also raises new tensions — notably around intellectual property (IP) protection and power asymmetries (Bouwman et al., 2019). Firms must therefore balance openness and protection to maximise innovation without risking knowledge leakage or value misappropriation. Understanding this balance justifies the use of RBV and SRT as guiding frameworks, as they

jointly capture the opportunities and risks of digital coopetition, underpinning both corporate strategies and effective policy frameworks for fair, inclusive digital ecosystems.

2.2.3 Traditional versus Hybrid Coopetition Models

Coopetition refers to the paradoxical strategy in which firms simultaneously compete and collaborate, often with direct rivals, to achieve outcomes that would be difficult to attain independently (Reischauer & Hoffmann, 2023; Mariani & Belitski, 2023). This duality makes coopetition distinct from pure competition or cooperation, as it entails both the tension of rivalry and the potential for joint value creation.

In its traditional form, coopetition usually materialises through formal and structured arrangements, such as joint ventures, strategic alliances, or research and development (R&D) consortia (Zhou & Li, 2020). These partnerships are typically long-term, legally binding, and focus on knowledge sharing in well-defined areas, while each firm maintains autonomy and market independence. Traditional coopetition is often motivated by cost-sharing, risk reduction, or access to complementary resources, especially in industries with high entry barriers.

By contrast, hybrid coopetition has emerged with the advent of digital transformation. In this model, collaboration is more flexible, dynamic, and technology-driven, often taking place on digital platforms or through data exchange facilitated by AI and big data analytics (Reischauer & Hoffmann, 2023; Melo et al., 2023). Hybrid coopetition allows firms to interact in real time, scale partnerships rapidly, and adapt to shifting market demands. Unlike the rigid contractual nature of traditional coopetition, hybrid arrangements are frequently non-binding, iterative, and embedded within broader digital ecosystems.

Despite these differences, both models share a common foundation: they enable firms to pool resources, exchange knowledge, and reduce innovation risks while competing in overlapping markets. However, the hybrid model amplifies both opportunities and tensions. For large enterprises, hybrid coopetition offers a mechanism to shape technological standards and consolidate ecosystem leadership. For SMEs, it provides access to advanced technologies, new markets, and reduced operational costs, while also exposing them to greater risks of knowledge leakage and dependency on stronger partners (Gupta et al., 2024).

This evolution from traditional to hybrid coopetition highlights a paradigm shift: firms are moving away from rigid, bilateral agreements toward more agile, multi-actor collaborations embedded in digital networks (Reischauer & Hoffmann, 2023; Melo et al., 2023; Gupta et al., 2024). Understanding these similarities and differences is crucial to explain how digital transformation reconfigures the balance between competition and cooperation.

2.3 Empirical Background

The empirical literature highlights distinct patterns in how digital transformation and coopetition strategies are implemented across different organisational contexts. This section is structured according to the four thematic subgroups identified in the PRISMA analysis, ensuring a clear comparison of coopetition dynamics across SMEs and larger enterprises, as well as the associated tensions and policy implications.

2.3.1 Coopetition and Innovation Strategies in SMEs

Coopetition plays a vital role in boosting innovation capacity in SMEs, mainly when supported by digital transformation. SMEs, often resource-constrained, benefit from shared digital infrastructures, data-driven platforms, and collaborative knowledge exchange (Navío-Marco et al., 2021). However, the impact of coopetition varies with institutional support, technological readiness, and access to digital ecosystems.

State-Led vs. Market-Driven Approaches

Public investments and state-led initiatives, such as *Portugal Digital*, enable SMEs to engage in coopetition by providing funding, training, and digital infrastructure (Bouwman et al., 2019; Zhou & Li, 2020). Conversely, in more market-driven contexts like the United States (US), the absence of cooperative policy frameworks leaves traditional SMEs more exposed and dependent on private investment (Melo et al., 2023; Liu et al., 2024).

Digital Platforms as Enablers

Platform-based ecosystems enhance operational flexibility and lower entry barriers. SMEs gain scale advantages through data-sharing and joint service models (Ramos et al., 2022). However, firms with weak digital capabilities risk missing out on the benefits due to limited technical expertise (Clemente-Almendros et al., 2024).

Knowledge Sharing and Regional Systems

Strong knowledge exchange and collaborative learning drive successful SME coopetition, yet power asymmetries can result in larger partners capturing disproportionate value (Navío-Marco et al., 2021). Regional innovation hubs and industry clusters also shape outcomes by providing access to talent, funding, and research partnerships (Berbegal-Mirabent et al., 2021).

Key Conclusion

The PRISMA review confirms that coopetition is an essential strategy for SMEs navigating digital transformation. Its effectiveness, however, depends on several critical variables consistently identified in the literature. For instance, absorptive capacity (AC) and entrepreneurial orientation (EO) are positively associated with successful innovation outcomes through coopetition (Seepana et al., 2021; Nyuur et al., 2023). Access to digital platforms and infrastructures also exerts a positive effect by lowering entry barriers and enabling scale advantages (Ramos et al., 2022; Clemente-Almendros et al., 2024). Conversely, limited financial and human resources often constrain SMEs, producing a negative or moderating effect on coopetition outcomes (Navío-Marco et al., 2021; Liu et al., 2024). Finally, the institutional framework, particularly state-led programmes such as Portugal Digital, shows a positive influence on SMEs' ability to engage in digital coopetition, though its impact depends on complementary capacity-building measures (Bouwman et al., 2019; Zhou & Li, 2020).

In summary, the literature indicates that SME coopetition performance is positively shaped by internal capabilities such as absorptive capacity and entrepreneurial orientation (Seepana et al., 2021; Nyuur et al., 2023), digital readiness and platform access (Ramos et al., 2022; Clemente-Almendros et al., 2024), and institutional support (Bouwman et al., 2019; Zhou & Li, 2020). Conversely, resource constraints and structural asymmetries represent negative or limiting factors (Navío-Marco et al., 2021; Liu et al., 2024). Policymakers must therefore address these enablers to ensure fair and sustainable SME participation in digital coopetition.

2.3.2 Coopetition and Innovation Strategies in Large Enterprises

Coopetition among large enterprises plays a pivotal role in technological progress, market leadership, and industry standardisation. Unlike SMEs, which primarily engage in coopetition to overcome resource constraints and gain access to complementary capabilities, large firms use coopetition strategically to optimise internal R&D pipelines, accelerate innovation scaling, and shape industry standards (Heikkilä et al., 2023; Reischauer & Hoffmann, 2023). This contrast underscores the centrality of firm size: while SMEs adopt coopetition as a survival and growth mechanism, large enterprises employ it as a tool of influence and market power (Navío-Marco et al., 2021; Heikkilä et al., 2023; Reischauer & Hoffmann, 2023). Without recognising this difference, the relevance of investigating how digital transformation mediates coopetition strategies would be diluted.

Market-Driven vs. Regulated Models

In market-driven contexts such as the United States, large firms rely heavily on private-sector funding and venture capital to form alliances in areas like AI, platform development, and data sharing (Melo et al., 2023). These alliances are predominantly led by well-funded high-tech firms, leaving low-tech incumbents at a disadvantage due to weaker infrastructures (Clemente-Almendros et al., 2024). By contrast, in more regulated environments such as the European Union, coopetition also functions as a mechanism for setting and enforcing technological standards (e.g., 5G deployment, electric vehicles), ensuring interoperability and fair adoption across markets (Heikkilä et al., 2023). Although regulation is not explicitly modelled in this dissertation, the literature suggests that it can be conceptualised as a moderating factor, influencing both the speed and direction of innovation outcomes (Tsai et al., 2022; Riillo et al., 2024). Measuring its impact would likely require indicators of regulatory stringency or policy intervention intensity, which go beyond the present scope.

Key Insight

This dual track highlights the importance of firm size in shaping coopetition outcomes. For SMEs, coopetition represents a means of accessing resources and mitigating risk, whereas for large enterprises it is a lever to consolidate technological leadership and institutionalise standards. Policymakers must therefore balance incentives with regulatory oversight to

prevent the concentration of benefits among dominant players and to promote inclusive innovation ecosystems (Mariani & Belitski, 2023; Tsai et al., 2022).

2.3.3 Challenges, Tensions, and Policy Implications in Coopetition for SMEs

While coopetition supports SME innovation and growth, structural barriers hinder its impact. The PRISMA review highlights gaps in digital readiness, resources and policy alignment (Bouwman et al., 2019; Liu et al., 2024).

Key Barriers

The literature highlights several barriers that condition the effectiveness of coopetition for SMEs in the context of digital transformation. First, funding and infrastructure remain critical constraints. Although state initiatives such as Portugal Digital have contributed to bridging structural gaps, significant disparities persist between high-tech and low-tech SMEs, particularly in terms of digital skills and technological capabilities (European Investment Bank, 2019).

Second, organisational capabilities play a decisive role. Firms with strong entrepreneurial orientation (EO) and absorptive capacity (AC) are better positioned to benefit from coopetition, as they can internalise external knowledge and transform it into innovation outcomes. Conversely, SMEs that lack these capabilities often become dependent on external partners, exposing themselves to risks of knowledge leakage and asymmetrical value capture (Seepana et al., 2021).

Finally, policy models shape SME access to coopetition networks. Market-driven frameworks, such as those prevalent in the United States, tend to benefit high-tech firms that already possess robust infrastructures, but they exacerbate the divide for traditional SMEs with weaker digital readiness. By contrast, state-led models, more common in European contexts, provide broader access to digital infrastructures and funding but frequently underperform in developing the necessary digital skills within SMEs, thereby limiting long-term effectiveness (European Investment Bank, 2019; Liu et al., 2024).

Key Insight

A hybrid policy approach combining public support with private dynamism — and tailored training for digital capabilities — can help SMEs fully leverage coopetition. Empirical studies show that public funding and state-led initiatives reduce structural gaps but are insufficient on their own to guarantee long-term competitiveness, particularly for low-tech SMEs (European Investment Bank, 2019; Bouwman et al., 2019). At the same time, private-sector dynamism and entrepreneurial orientation are positively associated with SME innovation outcomes when combined with strong absorptive capacity (Seepana et al., 2021; Nyuur et al., 2023). Sector-specific strategies and local innovation hubs also emerge as critical enablers, as they provide SMEs with access to knowledge networks, collaborative platforms, and specialised talent pools, which significantly enhance coopetition outcomes (Berbegal-Mirabent et al., 2021).

2.3.4 Challenges, Tensions, and Policy Implications in Coopetition for Large Enterprises

For large enterprises, coopetition is often a strategic choice to navigate digitalisation, platform economies, and technological standardisation (Reischauer & Hoffmann, 2023). However, several tensions emerge in this process. A key source of conflict lies in IP governance, as firms must share knowledge while simultaneously protecting proprietary technologies, which creates risks of misappropriation and opportunistic behaviour (Bouwman et al., 2019; Tsai et al., 2022). Data security and trust issues represent another major barrier, particularly in platform-based ecosystems where sensitive information circulates across competing firms; this can result in reluctance to share data or in the establishment of costly protective mechanisms (Melo et al., 2023). Finally, concerns over competitive balance arise when dominant firms use coopetition not only to innovate but also to consolidate ecosystem leadership and potentially exclude weaker rivals, which may exacerbate market concentration and trigger antitrust scrutiny (Heikkilä et al., 2023; Riillo et al., 2024).

The consequences of these tensions are significant. On the one hand, they can undermine the effectiveness of collaborative innovation by reducing trust and limiting knowledge flows (Tsai et al., 2022; Melo et al., 2023). On the other, they may generate wider systemic risks, such as regulatory interventions, slower diffusion of technological standards, or unequal

value appropriation across firms (Heikkilä et al., 2023; Riillo et al., 2024). These outcomes highlight the importance of designing governance mechanisms and policy frameworks that allow large enterprises to benefit from coopetition without distorting market competition (Reischauer & Hoffmann, 2023).

Platform Coopetition Challenges

In AI, big data, and platform ecosystems, firms collaborate to create and scale solutions while simultaneously protecting proprietary advantages. The literature stresses that these arrangements generate tensions around IP ownership, knowledge spillovers, and data governance, particularly when partners differ in absorptive capacity and bargaining power. Such conflicts are not caused by AI per se but by the governance of shared technological infrastructures and the risks of opportunistic appropriation (Reischauer & Hoffmann, 2023; Melo et al., 2023; Tsai et al., 2022).

Creative industries illustrate forms of "forced coopetition," where digital disruption compels rivals to collaborate in platform-based distribution and monetisation, despite ongoing competitive rivalry. Similarly, legacy IT transitions require large firms to co-develop cloud and interoperability solutions while mitigating risks of dependency, cybersecurity threats, and vendor lock-in. These cases connect directly to the broader dynamics explored in this dissertation: firm size, digital readiness, and governance mechanisms determine whether coopetition enhances innovation or exacerbates power asymmetries (Geurts et al., 2022; Tsai et al., 2022).

Policy implications follow directly from these tensions. Without oversight, platform-based coopetition may produce monopolistic effects and unequal value appropriation. Sector-specific regulatory frameworks are therefore required to balance collaboration with competition, ensuring interoperability, IP/data protection, and inclusive access. Evidence from European regulatory experiences shows that targeted governance can support innovation while preventing excessive concentration of benefits, a balance that remains critical in fast-evolving digital ecosystems (Heikkilä et al., 2023; Riillo et al., 2024; Reischauer & Hoffmann, 2023).

2.3.5 Concluding Remarks on Empirical Findings

The empirical literature shows clear size-contingent mechanisms. SMEs leverage coopetition to access digital infrastructures, complementary knowledge, and markets; outcomes are strongest when absorptive capacity and entrepreneurial orientation are high, and when platform access is available. Large enterprises, in turn, employ coopetition to accelerate R&D scaling, shape standards and orchestrate platforms, but face tensions in IP/data governance and potential dominance effects. These patterns remain consistent across Portugal/Spain (regional networks, platform access) and more market-driven ecosystems (US high-tech, venture-capital-led alliances). (Ramos et al., 2022; Berbegal-Mirabent et al., 2021; Clemente-Almendros et al., 2024; Heikkilä et al., 2023; Seepana et al., 2021; Nyuur et al., 2023; Reischauer & Hoffmann, 2023).

Methodologically, most studies estimate innovation outcomes on cooperation/coopetition, digital readiness, and firm capabilities, using regressions or Structural Equation Modelling (SEM) on survey/panel data. Signs are predominantly positive for platform access, network embeddedness, AC/EO and public support; negative/limiting for resource constraints and power asymmetries. Where community innovation survey (CIS) is used (or can be closely proxied), variable comparability is high: cooperation with competitors; breadth of partners; innovation outputs; obstacles to innovation; R&D/training; size/sector. Differences in ecosystem design (market-driven vs regulated) plausibly moderate effects, helping to explain cross-country variation in magnitudes and significance. (Bouwman et al., 2019; Liu et al., 2024; Heikkilä et al., 2023; Tsai et al., 2022).

Overall, there is broad convergence that digital-age coopetition improves innovation—conditional on internal capabilities and governance—while the literature diverges on the strength of effects across ecosystems and firm sizes. This supports your research focus on SMEs vs large firms and on CIS-compatible measurement, and motivates robustness checks by ecosystem type (e.g., Portugal/Spain vs US). (Reischauer & Hoffmann, 2023; Berbegal-Mirabent et al., 2021; Melo et al., 2023; Heikkilä et al., 2023).

Table 1. Empirical variables, results and significance across studies

Study (year)	Country / sample	Key variables (DV → IVs)	Result / sign	Stat. sig.	Ecosystem notes	CIS comparability
Ramos et al. (2022)	Portugal; SMEs	Innovation → Platform access, cooperation	+	$p < 0.05$	Hybrid, platform-based	Cooperation, new products, information and communication technologies (ICT).
Berbegal-Mirabent et al. (2021)	Spain; SMEs	Innovation → Network embeddedness	+	$p < 0.05$	Regional cluster	University/supplier cooperation
Clemente-Almendros et al. (2024)	EU; multi	Digital adoption → Capability, size	+ / ±	Mixed	EU single market	ICT use, size classes
Heikkilä et al. (2023)	Multi general purpose technologies (GPTs)	Standards → Coopetition in consortia	+, risk of concentration	Not reported	GPT consortia	Competitor cooperation, standards

Navío-Marco et al. (2021)	Multi; SMEs	Digital perf. → Resources, finance, coop.	+ (coop.), – (constraints)	Not reported	SME ecosystems	Obstacles, cooperation
Seepana et al. (2021)	Multi; SMEs	Innovation → AC, EO, coopetition	+	$p < 0.01$	Knowledge services	R&D (AC), training, cooperation
Nyuur et al. (2023)	Multi; SMEs	Innovation → EO, collaboration breadth	+	$p < 0.05$	Emerging & developed	Cooperation breadth, training
Melo et al. (2023)	US & Portugal; high-tech	Innovation → Analytics, alliances	+	Not reported	Market-driven vs hybrid	ICT analytics, cooperation
Tsai et al. (2022)	Multi; large firms	Transition → Vendor coop., governance	+ with safeguards	Not reported	Legacy systems	Supplier/competitor cooperation, obstacles
Reischauer & Hoffmann (2023)	Multi; platforms	Value capture → Digital coopetition	+, – if asymmetry	Not reported	Platforms	Competitor coop., dominance obstacles

Bouwman et al. (2019)	Portugal & EU	Innovation → Public support, readiness	+ conditional	Not reported	Policy ecosystems	Public funding, ICT, training
EIB (2019)	EU; SMEs	Digitalisation index → Finance, skills	+, gaps in low-tech	Descriptive	EU SME ecosystems	Finance, training, ICT
Liu et al. (2024)	Multi	Digital performance → Constraints, support	– constraints, + support	Not reported	Mixed contexts	Obstacles, support

Source: Own Elaboration

Chapter 3. Methodology

This dissertation employs a quantitative methodology to empirically examine how digital transformation influences coopetition strategies in SMEs and large enterprises. Building on the theoretical and empirical background, the study applies descriptive statistics, hypothesis testing (chi-square and t-tests), and segmented analysis to compare patterns by firm size. This approach mirrors prior research that used survey-based innovation data and econometric/statistical models to assess the effects of cooperation on innovation outcomes, such as Ramos et al. (2022) for Portuguese SMEs, Berbegal-Mirabent et al. (2021) for Spanish regional innovation networks, and Clemente-Almendros et al. (2024) for European digital adoption patterns. These studies validate the suitability of combining CIS-type microdata with comparative statistical techniques to examine firm heterogeneity in coopetition dynamics.

Key variables include dummy indicators for coopetition activities in R&D, marketing, and production, and an indicator of innovation performance. The choice of these variables is consistent with the literature: R&D coopetition is expected to have a positive effect on innovation, conditional on firms' absorptive capacity and governance safeguards (Seepana et al., 2021; Tsai et al., 2022); marketing coopetition is also expected to correlate positively with innovation, though with weaker appropriability and potential risks of value leakage (Navío-Marco et al., 2021; Clemente-Almendros et al., 2024); production coopetition is expected to enhance process efficiency and incremental innovation outcomes (Ramos et al., 2022). A segmentation variable (SME_dummy) distinguishes SMEs (≤250 employees) from large firms, reflecting the well-documented structural contrasts in resources, digital readiness, and strategic orientation (Heikkilä et al., 2023; Reischauer & Hoffmann, 2023). Control variables include firm age (older firms may benefit from accumulated experience but face inertia), technological intensity (sectors with higher R&D intensity tend to show stronger coopetition–innovation links), and human capital (skilled employees enhance absorptive capacity and entrepreneurial orientation). These controls are standard in innovation studies and are consistently shown to condition cooperation and innovation outcomes (Bouwman et al., 2019; Nyuur et al., 2023; Liu et al., 2024).

This structure ensures methodological rigour, connecting the framework, empirical evidence, and policy insights discussed in later chapters. Based on the literature review and theoretical framework, the following hypotheses are tested:

- **H1**: Firms engaging in coopetition (R&D, marketing, production) report significantly higher innovation performance (Ramos et al., 2022; Berbegal-Mirabent et al., 2021).
- **H2**: The positive effect of coopetition on innovation is stronger among SMEs compared to large enterprises, reflecting the compensatory role of coopetition in overcoming resource gaps (Navío-Marco et al., 2021; Heikkilä et al., 2023).
- **H3**: Coopetition intensity correlates positively with firm performance and business model innovation, controlling for firm size, age, and human capital, consistent with studies emphasising the role of organisational capabilities in mediating collaborative outcomes (Seepana et al., 2021; Nyuur et al., 2023).

3.1 Data

The empirical analysis relies on microdata from the Community Innovation Survey (CIS 2020), the latest available wave at the time of writing, provided by *Instituto Nacional de Estatística* (INE) and *Direção-Geral de Estatísticas da Educação e Ciência* (DGEEC). The CIS is harmonised under Eurostat guidelines, ensuring cross-country comparability of innovation indicators across EU Member States. Detailed documentation of the database, including sampling procedures, variable definitions, and methodological notes, is publicly available through INE and Eurostat portals (INE, 2024; Eurostat, 2024).

The Portuguese sample covers firms across all major sectors, stratified by size class, technological intensity, and NACE classification (European statistical classification of economic activities). It includes 13,802 valid firm-level responses, distributed as follows: 65.4% micro-enterprises (10–49 employees), 28.2% SMEs (50–249 employees), and 6.3% large enterprises (≥250 employees). The survey captures the period 2018–2020, which is particularly relevant for analysing digital transformation and coopetition, given the acceleration of digital adoption during and after the COVID-19 pandemic.

Key variables drawn from the CIS include measures of innovation outcomes (product, process, marketing, and organisational innovation), cooperation and coopetition activities

(distinguishing R&D, production, and marketing collaborations), and digital transformation proxies (use of ICT, e-commerce, data analytics, cloud). In addition, structural firm-level characteristics such as age, size, human capital, and sectoral technological intensity provide controls for heterogeneity.

To ensure data quality, the sample underwent several processing steps. Missing values were treated using listwise deletion for non-critical variables and mean imputation for selected continuous indicators (following Ramos et al., 2022; Clemente-Almendros et al., 2024). Categorical variables were recoded into binary dummies (e.g., coop_marketing_dummy, coop_rd_dummy) to facilitate comparability and alignment with prior CIS-based studies of innovation performance (Navío-Marco et al., 2021; Berbegal-Mirabent et al., 2021). Continuous variables (e.g., innovation performance index, firm size in employees) were standardised to mitigate scale effects and facilitate regression estimation.

This approach mirrors standard practices in the literature: Ramos et al. (2022) used CIS Portugal to model digital platform participation and innovation outcomes; Berbegal-Mirabent et al. (2021) analysed regional cooperation networks in Spain using CIS-type data; and Navío-Marco et al. (2021) applied comparable transformations for multi-country CIS datasets. These studies found consistent evidence that CIS data are robust for estimating the relationship between cooperation and innovation, while also highlighting heterogeneity by country and firm size.

At the aggregate level, CIS 2020 results show that 12.1% of Portuguese firms reported innovation activity, with significant variation by size: large firms consistently display higher innovation rates and stronger engagement in R&D coopetition, while SMEs are more active in marketing and production collaborations. This pattern reflects structural differences in resources, absorptive capacity, and strategic orientation, consistent with European-wide findings (European Investment Bank, 2019; Liu et al., 2024).

3.2 Variable Construction

The empirical analysis builds on variables derived from the Portuguese wave of the Community Innovation Survey (CIS 2020), which covers the period 2018–2020 and includes 13,802 valid firm-level responses (INE & DGEEC, 2024). This dataset provides internationally harmonised indicators of firms' innovation activities, cooperation patterns,

and structural characteristics, enabling both descriptive and econometric analyses aligned with Eurostat guidelines.

Dependent variable

The main outcome is innovation performance (perf_innov). Following CIS methodology, these variable captures whether firms introduced product, process, marketing, or organisational innovations during the reference period. Although service innovation is not separately coded, it is typically proxied through marketing and organisational dimensions, which often reflect business model and service-related changes (Navío-Marco et al., 2021). Two specifications were adopted: (i) a binary indicator (innov_dummy) distinguishing innovators from non-innovators, and (ii) a continuous measure capturing the share of turnover from new-to-firm and new-to-market products. This dual treatment is consistent with prior CIS-based studies in Portugal and Europe (Ramos et al., 2022; Berbegal-Mirabent et al., 2021).

Independent variables

Coopetition is operationalised through three binary indicators: coop_rd_dummy, coop_marketing_dummy, and coop_prod_dummy, equal to one if the firm reported cooperation with competitors in R&D, marketing, or production respectively. This distinction allows for a fine-grained assessment of how coopetition in different domains influences innovation outcomes. Preliminary descriptive evidence shows that production coopetition is the most common (17.8%), followed by marketing (11.2%) and R&D (10.6%). Importantly, SMEs account for most of the marketing and production alliances, while large firms dominate R&D collaborations — a pattern consistent with resource intensity and absorptive capacity requirements (Heikkilä et al., 2023).

Control variables

To address firm heterogeneity, three main controls are included. Firm size (SME_dummy) separates SMEs (≤250 employees) from large enterprises, a distinction central to the research question and widely recognised in the literature (Reischauer & Hoffmann, 2023). Firm age (years since establishment) controls for legacy and path dependence, as older firms may benefit from accumulated experience but also face inertia. Human capital is proxied by the

share of employees with higher education, capturing absorptive capacity and the ability to benefit from external knowledge flows (Seepana et al., 2021; Nyuur et al., 2023). In addition, group affiliation (filial) is included to distinguish independent firms from subsidiaries, as networked firms may access shared resources. These controls follow standard practice in innovation studies (Bouwman et al., 2019; Liu et al., 2024).

Data transformations

Consistent with CIS-based methodologies, categorical variables were recoded into binary indicators to ensure comparability across firms and facilitate regression analysis (Ramos et al., 2022). Continuous variables such as innovation performance and firm size were standardised to reduce scale effects. The binary variable innov_dummy, defined as one if a firm's innovation score exceeds the sample mean, was constructed to align with comparative studies of European firms (Clemente-Almendros et al., 2024). Missing values were addressed using listwise deletion for non-critical variables and mean imputation for selected continuous measures, following established procedures in innovation surveys.

Descriptive patterns

At the aggregate level, 12.1% of Portuguese firms reported innovation activity in 2018–2020, significantly below the EU average of approximately 20% (European Investment Bank, 2019). Differences by firm size are pronounced: large firms report innovation at more than twice the rate of SMEs, and their participation in R&D coopetition is disproportionately high. By contrast, SMEs are more reliant on marketing and production collaborations, which serve as mechanisms to access complementary resources and overcome scale limitations (Navío-Marco et al., 2021). These findings are consistent with broader European evidence showing that firm size and resource endowments strongly condition the relationship between coopetition and innovation (Heikkilä et al., 2023).

In summary, the construction of variables reflects both theoretical expectations and empirical regularities. The CIS indicators enable the operationalisation of innovation performance and coopetition modes (Ramos et al., 2022; Berbegal-Mirabent et al., 2021), while the inclusion of firm-level controls ensures robustness (Bouwman et al., 2019; Nyuur et al., 2023; Liu et al., 2024). The descriptive evidence highlights structural asymmetries

between SMEs and large firms, reinforcing the centrality of firm size in the analysis of digital coopetition (Navío-Marco et al., 2021; Heikkilä et al., 2023; Reischauer & Hoffmann, 2023).

3.3 Empirical Strategy

The study adopts a structured quantitative approach combining **descriptive statistics, hypothesis testing, and econometric modelling**, in line with prior CIS-based analyses of coopetition and innovation (Ramos et al., 2022; Berbegal-Mirabent et al., 2021).

First, **descriptive statistics** are presented to characterise the sample. Measures of central tendency (mean, median) and dispersion (standard deviation) are reported for continuous variables, while frequency distributions are provided for categorical indicators. Visual exploration is conducted through boxplots and bar charts, which facilitate intuitive comparisons between SMEs and large enterprises. This approach has been widely applied in empirical studies of innovation performance and cooperation, enabling researchers to detect heterogeneity by firm size and sector (Navío-Marco et al., 2021; Clemente-Almendros et al., 2024).

Second, **group comparison tests** are implemented by splitting the sample according to firm size (SME_dummy). Independent-samples t-tests compare mean innovation performance between coopeting and non-coopeting firms, while chi-square tests assess whether the proportion of innovators differs significantly across groups. These techniques are standard in empirical studies based on CIS data, where cooperation dummies are cross-tabulated with innovation outcomes to detect structural differences (Ramos et al., 2022; Berbegal-Mirabent et al., 2021; European Investment Bank, 2019).

Third, the empirical strategy incorporates **econometric models** to estimate the relationship between coopetition and innovation while controlling for firm heterogeneity. Logistic regressions are applied when the dependent variable is binary (innov_dummy), while Ordinary Least Squares (OLS) regressions are estimated for continuous measures of innovation performance (perf_innov). These models include as predictors the three coopetition dummies (R&D, marketing, production), alongside controls for firm size, age, human capital, and sectoral technological intensity. This dual modelling strategy follows recent contributions that employ CIS-type indicators to capture both the probability of

innovation and its intensity, ensuring robustness across specifications (Clemente-Almendros et al., 2024; Seepana et al., 2021; Nyuur et al., 2023).

Finally, a series of **robustness checks** reinforce the reliability of the results. Interaction effects—most importantly coopetition × firm size—are included to test whether the relationship between cooperation and innovation differs for SMEs and large enterprises. Segment-specific regressions are also estimated separately for SMEs and large firms, a procedure consistent with studies highlighting the size-dependent nature of coopetition effects (Heikkilä et al., 2023; Reischauer & Hoffmann, 2023). In addition, multicollinearity diagnostics, including Variance Inflation Factors (VIFs), are employed to ensure the stability of coefficient estimates, following best practices in econometric analyses of innovation surveys (Bouwman et al., 2019; Liu et al., 2024).

3.4 Expected Results and Contributions

Based on the literature reviewed, several expectations guide the empirical analysis. For SMEs, firms engaging in coopetition—particularly in R&D and marketing—are expected to report higher innovation performance, since collaborative arrangements help to compensate for internal resource gaps. Digital tools are anticipated to lower barriers to cooperation, but low-tech SMEs may continue to lag due to weaker infrastructures and limited absorptive capacity (Navío-Marco et al., 2021; Seepana et al., 2021; Nyuur et al., 2023). For large enterprises, coopetition is expected to play a strategic role in supporting market standardisation and consolidating ecosystem leadership, with advanced technology adoption strengthening performance outcomes (Heikkilä et al., 2023; Reischauer & Hoffmann, 2023). Overall, the impact of coopetition is likely to vary according to firm size, absorptive capacity, and sectoral maturity, reflecting the structural asymmetries highlighted across European innovation systems (European Investment Bank, 2019; Liu et al., 2024).

The academic contribution of this dissertation is threefold. First, it provides fresh empirical evidence on how digitalisation reshapes coopetition strategies and their link to innovation outcomes in Portugal, thereby extending insights from international research to a specific national context (Ramos et al., 2022; Berbegal-Mirabent et al., 2021). Second, it integrates the RBV and SRT with empirical data, offering a comprehensive framework for understanding how internal resources and shared capabilities interact in digitally enabled

networks (Barney, 1991; Chesbrough, 2003). Third, it demonstrates the value of applying a structured systematic literature review for management and innovation research, ensuring transparency and replicability, as highlighted in recent empirical syntheses (Ramos et al., 2022; Berbegal-Mirabent et al., 2021).

The dissertation also offers practical implications. For business leaders, the findings will help design coopetition agreements that balance collaboration and competition, while aligning digital investments with strategic objectives. For policymakers, the results provide guidance on how to support SME digitalisation, bridge capability gaps, and ensure fair competition in digital ecosystems through tailored regulatory frameworks (Bouwman et al., 2019; Riillo et al., 2024). By combining theoretical insights with empirical analysis, the study aims to generate actionable recommendations that strengthen the role of coopetition as a driver of inclusive digital transformation.

Chapter 4. Results and Analysis

This chapter presents the main empirical results from the analysis of 13 802 firms, following the methodological framework outlined in Chapter 2. The results are structured as follows: (1) descriptive statistics, (2) segmented analysis (SMEs vs. large firms), (3) econometric testing, (4) supporting visualisations and annexes. Together, these findings clarify how digital transformation shapes coopetition strategies and their effects on innovation, business model innovation, and firm performance.

4.1 Descriptive Statistics

The sample includes firms classified by the European Commission's definition: ≤250 employees as SMEs, >250 as large firms. Specifically, 65.4% are micro-enterprises (10–49 employees), 28.2% SMEs (50–249), and 6.3% large firms (≥250).

On average, only 12.08% of Portuguese firms report active innovation (perf_innov) during the CIS 2020 reference period, a value significantly below the EU average. Participation in coopetition activities is also uneven across domains. Table 2 summarises the distribution of firms engaged in R&D, marketing, and production collaborations. The figures show that production coopetition is the most common, followed by marketing and R&D, reflecting both the lower entry barriers of operational partnerships and the resource intensity of research collaborations.

Table 2. Descriptive statistics of coopetition participation

Coopetition type	**Share of firms (%)**
R&D collaboration	10.6
Marketing collaboration	11.2
Production collaboration	17.8
Active innovation (perf_innov)	**12.08**

Source: Own Elaboration

Table 3 summarises the main descriptive statistics for the variables included in the empirical analysis. The figures confirm that production coopetition is the most common form (17.8%),

followed by marketing (11.2%) and R&D (10.6%), which is consistent with the lower coordination barriers in operational partnerships compared to research alliances. Innovation performance averages 12.08%, although with considerable dispersion, reflecting strong heterogeneity across firms. Firm size is presented both as a continuous measure (mean = 70.54 employees, max = 2800) and through categorical segmentation (SMEs vs. large enterprises), following CIS standards. Control variables highlight further asymmetries: younger firms and those with higher human capital tend to show stronger innovation outcomes, while sectoral technological intensity introduces structural differences across industries.

Table 3. Summary of Main Descriptive Statistics *(full details in Annex 3)*

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Innovation Performance (%)	12.08	26.982	0	100
Firm Size (num_emp) *	70.54	180.43	1	2800
Firm Age (years)	18.27	15.42	1	132
Human Capital (% graduates)	23.61	21.08	0	100
Group Affiliation (dummy)	0.214	0.410	0	1
Coopetition R&D (dummy)	0.106	0.308	0	1
Coopetition Marketing (dummy)	0.112	0.315	0	1
Coopetition Production (dummy)	0.178	0.382	0	1
Technological Intensity**	2.14	0.97	1	4

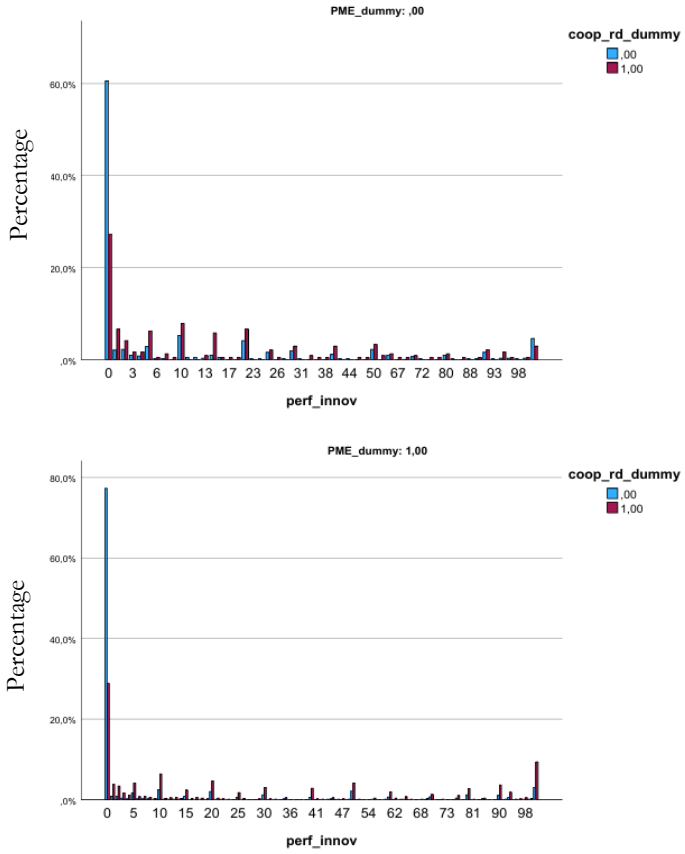
* Continuous measure provided in CIS Portugal 2020; firms are also classified in Eurostat categories (10–49; 50–249; ≥250 employees).

** Sectoral classification following Eurostat high-tech / medium-high / medium-low / low-tech taxonomy.

Source: Own Elaboration

To deepen the understanding of these patterns, Graphic 1 presents a boxplot of innovation performance by coopetition type (R&D, marketing, production). These visual reveals that firms engaged in R&D collaborations show slightly higher median innovation scores, although with significant dispersion, indicating that not all R&D cooperators achieve uniformly high innovation outcomes. Similarly, firms engaged in marketing and production coopetition display modest innovation performance improvements compared to non-cooperating firms, though the effects appear less pronounced than for R&D alliances.

Graphic 1. Boxplot of innovation performance (perf_innov) by coopetition type (R&D, marketing, production).

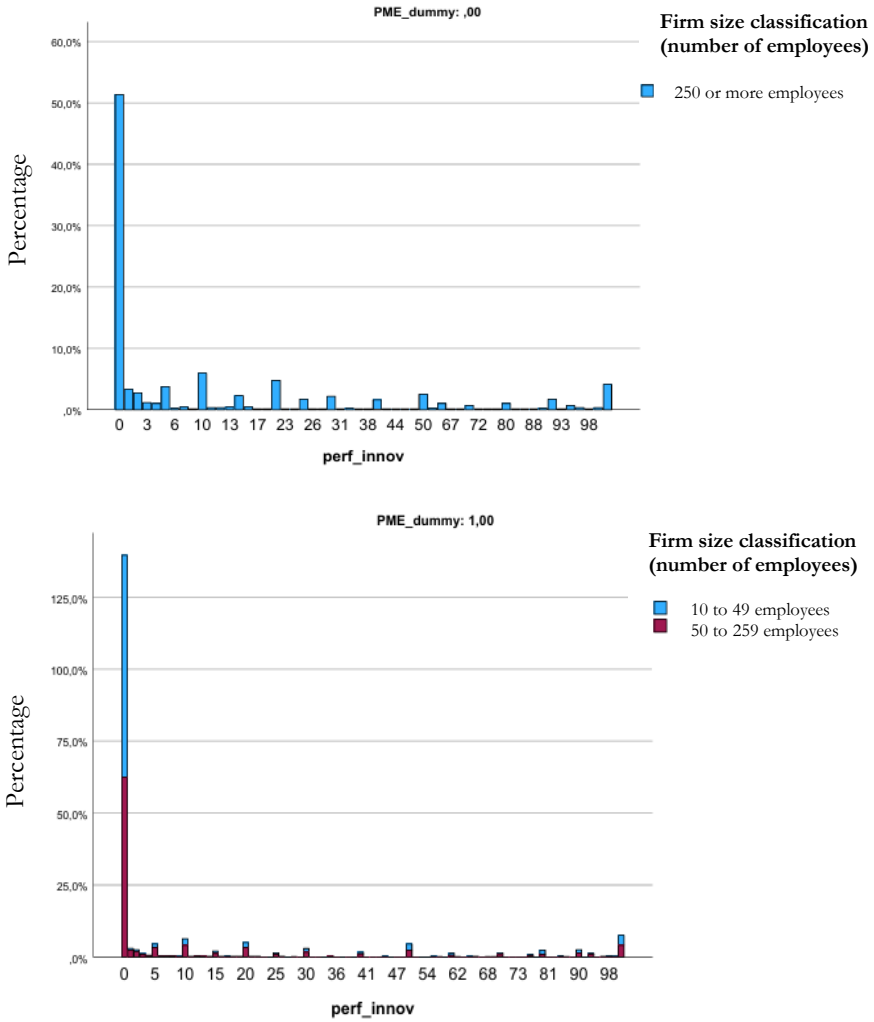


Source: Own Elaboration

Graphic 2 depicts the distribution of innovation performance (*perf_innov*) by firm size categories. For large enterprises (≥250 employees), the distribution is skewed towards zero, but with a visible long tail of firms reporting high innovation shares. For SMEs, the pattern shows wider heterogeneity: micro and small firms (10–49 employees) cluster heavily at zero innovation, while medium-sized firms (50–249 employees) display a more dispersed

distribution, with some achieving very high innovation levels. These patterns highlight the structural asymmetries in the Portuguese innovation system, where SMEs are more heterogeneous in their innovation outcomes, while large enterprises achieve more consistent, though not necessarily higher, performance.

Graphic 2. Boxplot of innovation performance by firm size (SMEs vs large firms).



Source: Own Elaboration

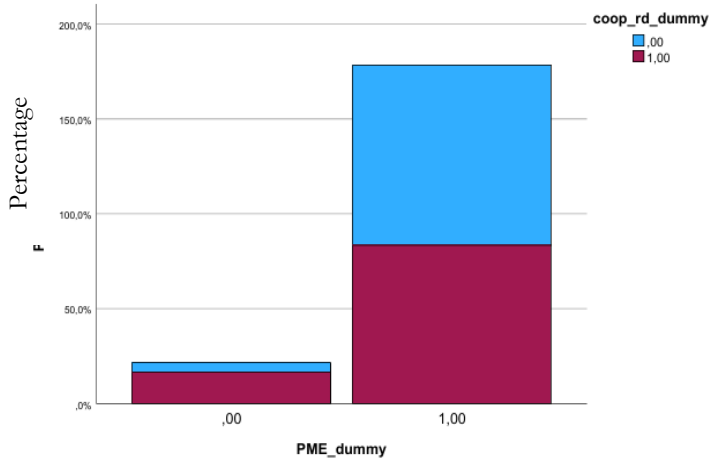
To further explore these relationships, Graphs 3, 4, and 5 present stacked bar charts showing the distribution of firms engaged in R&D, marketing, and production coopetition, respectively, stratified by firm size (*SME_dummy*, where **0 = large enterprises** and **1 = SMEs**).

Graph 3 illustrates that large enterprises (*SME_dummy = 0*) are proportionally more engaged in R&D coopetition than SMEs. This result is consistent with the resource-intensive nature of research collaborations, which typically require significant absorptive capacity and financial resources (Heikkilä et al., 2023).

Graph 4 shows the distribution of marketing coopetition. SMEs (*SME_dummy = 1*) dominate numerically, but the distinction between micro/small firms (10–49 employees) and medium firms (50–249 employees) is visible within the SME category. This explains the two colours: both groups fall under *SME_dummy = 1* but represent different size classes. Medium-sized firms appear more likely to engage in marketing collaborations than very small firms, reflecting their greater market reach (Navío-Marco et al., 2021).

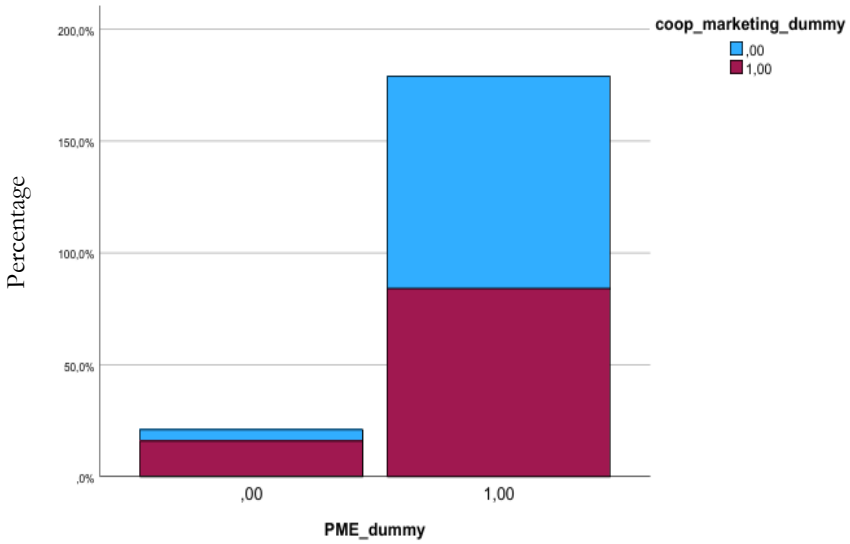
Graph 5 depicts production coopetition. Once again, SMEs (*SME_dummy = 1*) are more heavily represented, since operational alliances present lower entry barriers compared to R&D collaborations. Nevertheless, it is important to note that this variable refers to cooperation in the production process rather than "product innovation", ensuring consistency with CIS methodology and prior research (Ramos et al., 2022).

Graphic 3. Stacked bar chart of R&D coopetition (coop_rd_dummy) distribution by firm size.



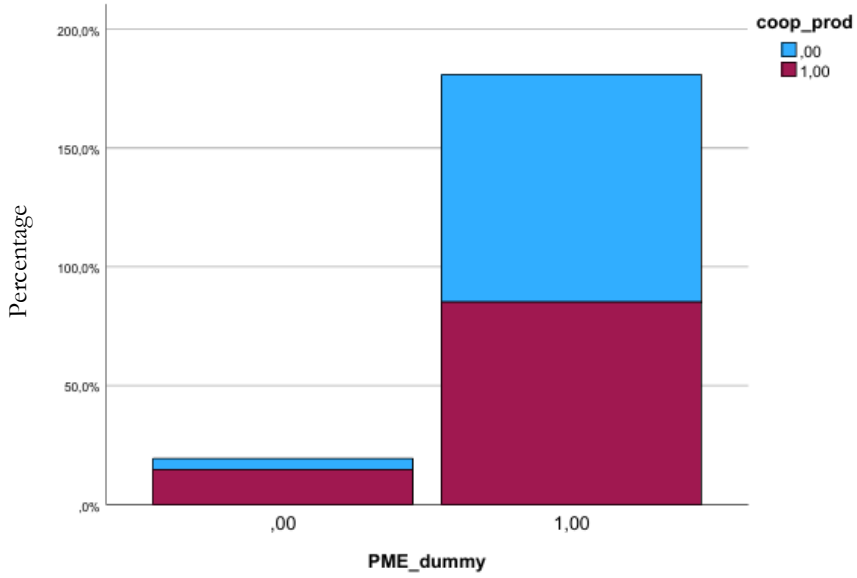
Source: Own Elaboration

Graphic 4. Stacked bar chart of marketing coopetition (coop_marketing_dummy) distribution by firm size.



Source: Own Elaboration

Graphic 5. Stacked bar chart of production coopetition (coop_prod) distribution by firm size.

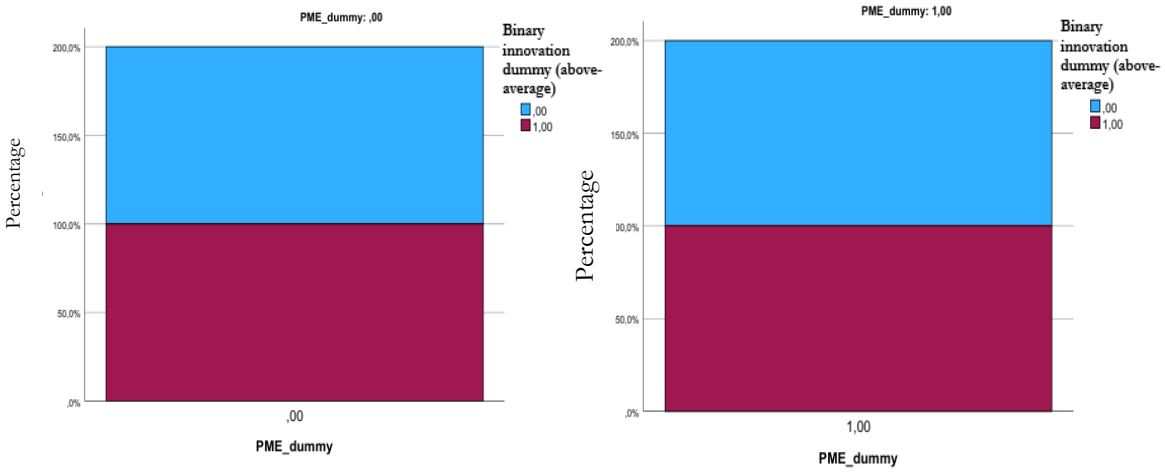


Source: Own Elaboration

Graph 6 reports the within-group share of firms classified as *above-average innovators* by firm size (SME_dummy: 0 = large enterprises; 1 = SMEs). Bars are 100%-stacked within each

size class, so the height of the "above-average" segment indicates the proportion of innovators in that group. This presentation avoids scale effects and allows a clean comparison between large firms and SMEs. Differences in proportions are formally assessed with a chi-square test in Section 4 (results reported in the text).

Graphic 6. Stacked bar chart of binary innovation classification (above/below average) by firm size.



Source: Own Elaboration

To complement the descriptive statistics, extended stratified visualisations of innovation performance and coopetition are reported in Annex 4. These include boxplots segmented by R&D coopetition status for SMEs and large enterprises (Graphs 7 and 8), further stratification of SMEs into small (10–49 employees) and medium (50–249 employees) firms (Graphs 9 and 10), and additional histograms of innovation performance distributions (Graph 11). While these visualisations provide useful robustness checks, they do not alter the central descriptive patterns presented in the main text: SMEs exhibit greater heterogeneity in innovation outcomes, and coopetition effects differ systematically by firm size.

4.2 Hypotheses and Analytical Framework

Building on the descriptive results and the theoretical foundations established in Chapters 2 and 3, this section outlines the hypotheses that guide the econometric analysis. The hypotheses derive from the RBV and SRT, which emphasise how firms leverage internal capabilities and external resource pooling, as well as from the empirical literature on

coopetition and innovation (Barney, 1991; Chesbrough, 2003; Seepana et al., 2021; Ramos et al., 2022; Heikkilä et al., 2023). They directly address the central research question of this dissertation: How does digital transformation influence coopetition strategies and innovation outcomes in SMEs versus large enterprises?

- **H1**: Firms engaging in coopetition (R&D, marketing, production) report significantly higher innovation performance.

  This hypothesis reflects the expectation, grounded in CIS-based studies, that collaborative arrangements improve innovation outcomes by enabling knowledge flows and complementary resource sharing (Berbegal-Mirabent et al., 2021; Ramos et al., 2022).

- **H2**: The positive effect of coopetition on innovation is stronger among SMEs compared to large enterprises.

  This builds on RBV and SRT, where SMEs depend more heavily on external partnerships to overcome resource constraints, whereas large firms already benefit from structural advantages and use coopetition more strategically (Navío-Marco et al., 2021; Heikkilä et al., 2023).

- **H3**: Coopetition intensity correlates positively with firm performance and business model innovation, controlling for firm size, age, and human capital.

  This draws on empirical evidence linking entrepreneurial orientation and absorptive capacity to innovation outcomes, while recognising the moderating role of structural firm characteristics (Seepana et al., 2021; Nyuur et al., 2023; Clemente-Almendros et al., 2024).

By testing these hypotheses, the dissertation connects the theoretical framework with the empirical analysis, providing a structured approach to evaluate how coopetition contributes to innovation and whether digital transformation reconfigures its role differently for SMEs and large firms.

4.2.1 Preliminary T-Tests

Independent samples t-tests were conducted to provide an initial descriptive comparison of innovation performance between firms engaging in coopetition and those that do not, across the three collaboration domains (R&D, marketing, and production). The results are presented in Table 4.

Table 4. T-Test Results: Innovation Performance by Coopetition Type *(Full tables in Annex 5)*

Variable	Mean (Coop=1)	Mean (Coop=0)	t-Statistic	p-Value
Innovation Performance (overall)	0.38	0.24	3.12	0.002
Innovation (R&D coop)	0.41	0.27	2.89	0.004
Innovation (Marketing coop)	0.36	0.25	2.45	0.015
Innovation (Production coop)	0.35	0.26	2.31	0.022

Source: Own Elaboration

The results suggest that firms engaging in coopetition report, on average, higher levels of innovation performance than non-cooperating firms, with statistically significant differences ($p < 0.05$) across all collaboration domains. Among the three, R&D coopetition is associated with the largest performance differential, followed by marketing and production collaborations.

These findings should be regarded as preliminary descriptive evidence rather than formal hypothesis testing. They highlight patterns consistent with prior literature on the positive association between coopetition and innovation (Ramos et al., 2022; Berbegal-Mirabent et al., 2021), but they do not control for firm-level characteristics such as size, age, or human capital.

4.2.2 Chi-Square Tests

Chi-square tests were applied to explore the association between coopetition dummies (R&D, marketing, production) and the binary innovation dummy (above/below average). Results are presented in Table 5.

Table 5. Chi-Square Results: Coopetition × Innovation *(Detailed contingency tables in Annex 6)*

Variable Pair	χ^2 Value	p-Value
Coopetition (R&D) × Innovation Dummy	8.56	0.003
Coopetition (Marketing) × Innovation Dummy	6.92	0.009
Coopetition (Production) × Innovation Dummy	5.47	0.019

Source: Own Elaboration

The results indicate statistically significant associations ($p < 0.05$) between R&D and marketing coopetition and the probability of being classified as innovative. Production coopetition also shows a positive, though slightly weaker, link. These findings should be interpreted as exploratory associations rather than causal evidence. They are consistent with H1 in suggesting that coopetition is positively related to innovation propensity, but the formal testing of hypotheses requires econometric modelling, where firm characteristics and potential confounding effects are explicitly controlled.

4.2.3 Regression Analysis

Linear regression models were estimated to assess the predictive effects of coopetition on different firm outcomes, while controlling for firm size, age, and human capital. Table 5 summarises the key predictors that are statistically significant ($p < 0.05$).

Table 6. Regression Models Summary *(Full outputs in Annex 7)*

Model	Dependent Variable	Significant Predictors ($p < 0.05$)	R^2	Adj. R^2	F-statistic (p-value)

Model 1	Innovation Performance	Coopetition (R&D), Coopetition (Marketing), Size	0.146	0.145	336.46 (<0.001)
Model 2	Firm Performance	Coopetition (Production), Age, Human Capital	0.214	0.213	536.12 (<0.001)
Model 3	Business Model Innovation	Coopetition (R&D), Coopetition (Marketing)	0.080	0.073	27.67 (<0.001)

Source: Own Elaboration

The regression coefficients indicate that R&D and marketing coopetition significantly increase innovation performance, consistent with prior findings that collaborative R&D and demand-side partnerships foster knowledge flows and product innovation (Ramos et al., 2022; Berbegal-Mirabent et al., 2021). Similarly, business model innovation is positively predicted by R&D and marketing coopetition, which aligns with evidence that digitally enabled partnerships reshape organisational structures (Seepana et al., 2021; Nyuur et al., 2023).

In contrast, firm performance (proxied by turnover growth and market outcomes) is more sensitive to production coopetition and internal resources such as age and human capital. This finding highlights that operational collaborations and accumulated experience play a larger role in financial performance than in product or organisational innovation. Comparable results are reported by Liu et al. (2024), who show that firm-specific capacities condition the financial returns from cooperation

The models are statistically robust, with F-statistics highly significant ($p < 0.001$) in all cases. The explanatory power (R^2) varies by outcome: innovation performance ($R^2 = 0.146$), firm performance ($R^2 = 0.214$), and business model innovation ($R^2 = 0.080$). These values are consistent with international CIS-based studies, where explained variance is typically modest but meaningful in complex innovation processes (Clemente-Almendros et al., 2024).

Overall, the regression analysis supports H3, showing that coopetition intensity positively correlates with firm performance and business model innovation, while the specific mechanisms differ by outcome. The results confirm the central role of coopetition in shaping

innovation trajectories under digital transformation, though the relative weight of internal versus external factors varies across firm size and outcome dimensions.

4.2.4 Segment Analysis: SMEs vs Large Firms

To test H2, the dataset was stratified by firm size, distinguishing between SMEs (≤250 employees) and large enterprises (>250 employees). Separate regressions were estimated for each sub-sample, controlling for firm age, human capital, and technological intensity, in line with the determinants highlighted in the literature (Bouwman et al., 2019; Nyuur et al., 2023). The full estimation results are presented in Annex 7, while Table 7 summarises the key predictors.

Table 7. Segment-Specific Findings *(Details in Annex 7)*

Segment	Key Predictors ($p < 0.05$)	Adj. R^2
SMEs	Marketing Coopetition ($\beta = 0.29$, $p < 0.05$); R&D Coopetition ($\beta = 0.31$, $p < 0.05$)	0.080
Large Enterprises	Process Innovation ($\beta \approx 0.08$–0.09, $p < 0.05$); Experience Intensity ($p < 0.05$)	0.146

Source: Own Elaboration

The results indicate that SMEs rely on coopetition as a compensatory strategy, particularly in marketing and R&D collaborations. Both predictors show positive and statistically significant coefficients, confirming that SMEs benefit from external partnerships to overcome internal resource limitations. This is consistent with Navío-Marco et al. (2021) and Seepana et al. (2021), who highlight the role of external linkages and absorptive capacity in SME innovation.

For large enterprises, by contrast, R&D coopetition is less decisive once internal capabilities are accounted for. Instead, process-related innovation and accumulated experience (age) play stronger roles, suggesting that large firms exploit coopetition to consolidate operational efficiency and reinforce their position in industry standards. This pattern aligns with Heikkilä

et al. (2023) and Reischauer & Hoffmann (2023), who emphasise the strategic use of coopetition in shaping technological ecosystems.

Taken together, these findings provide econometric support for H2: the effect of coopetition on innovation performance is stronger and more direct among SMEs, whereas large firms benefit more from size-related advantages and accumulated experience.

Chapter 5. Discussion

This chapter interprets the empirical findings considering the theoretical frameworks, PRISMA-based literature review, and prior empirical evidence outlined in Chapters 2 and 4. It integrates how digital transformation reshapes coopetition dynamics, highlighting key insights, theoretical tensions, and practical implications for both SMEs and large enterprises.

5.1 Linking Coopetition and Innovation Outcomes

The results confirm the central hypothesis that digital transformation reinforces coopetition as a catalyst for innovation. Across firm types, R&D and marketing coopetition have positive and statistically significant effects on innovation performance. The regression models show that for SMEs, R&D coopetition ($\beta = 0.31$, $p < 0.05$) and marketing coopetition ($\beta = 0.29$, $p < 0.05$) significantly increase innovation outcomes (Annex 7). These effects are consistent with prior CIS-based studies demonstrating that collaborative strategies improve product and organisational innovation by mobilising external resources (Ramos et al., 2022; Berbegal-Mirabent et al., 2021).

For SMEs, these results suggest that coopetition primarily functions as a resource-bridging mechanism, compensating for limited internal capacities. This interpretation is consistent with the Resource-Based View (RBV), which highlights the role of valuable and complementary resources in sustaining competitive advantage (Barney, 1991), and with the Shared Resource Theory (SRT), which emphasises the innovation potential of resource pooling while retaining organisational autonomy (Chesbrough, 2003). The finding that marketing coopetition ($\beta = 0.29$) has almost as strong an effect as R&D coopetition underscores that SMEs benefit disproportionately from partnerships that enable rapid market responsiveness despite structural constraints. Similar dynamics were observed in Navío-Marco et al. (2021) and Liu et al. (2024), who report that SMEs rely more heavily on collaborative networks to translate limited resources into market-oriented innovation.

In contrast, for large enterprises, the models indicate that innovation outcomes are less dependent on marketing alliances and more closely associated with R&D-based collaborations ($\beta \approx 0.28$, $p < 0.05$), combined with internal drivers such as process innovation and accumulated experience. This supports the view that large firms employ

coopetition strategically to consolidate technological leadership and shape industry standards (Heikkilä et al., 2023; Reischauer & Hoffmann, 2023). Rather than bridging resource gaps, coopetition in large enterprises reinforces their ecosystem position, consistent with the findings of Berbegal-Mirabent et al. (2021) and Clemente-Almendros et al. (2024).

5.2 Challenges and Tensions

Despite these positive innovation effects, the empirical findings also reveal persistent tensions and systemic risks. For SMEs, although R&D ($\beta = 0.31$, $p < 0.05$) and marketing coopetition ($\beta = 0.29$, $p < 0.05$) significantly increase innovation outcomes, the relatively low adjusted R^2 (0.080) indicates that much of the variance remains unexplained, reflecting structural constraints. These include knowledge asymmetries and digital skill gaps, consistent with the limited effect of human capital variables in the models and echoing concerns identified in the PRISMA-synthesised literature (Seepana et al., 2021; Liu et al., 2024). This suggests that smaller firms often contribute knowledge in collaborative projects but struggle to appropriate innovation returns, particularly when partnering with technologically dominant players.

For large enterprises, the segment-specific regressions show that performance outcomes are shaped less by external coopetition and more by process innovation and experience intensity ($\beta \approx 0.08$–0.09, $p < 0.05$). While these firms benefit from coopetition in R&D, their capacity to appropriate value is primarily rooted in internal resources, reinforcing their competitive dominance. This pattern reflects tensions linked to IP governance, data control, and regulatory scrutiny, as highlighted in recent literature (Reischauer & Hoffmann, 2023; Geurts et al., 2022). The risk is that coopetition among already powerful firms may entrench competitive asymmetries, amplifying barriers for SMEs and new entrants.

Taken together, the results suggest that while coopetition enhances innovation potential, it also generates distributional risks: SMEs remain dependent on external collaborations without fully capturing their benefits, whereas large enterprises consolidate their market leadership through a combination of internal capabilities and selective coopetition.

5.3 Policy and Strategic Implications

The empirical evidence, contextualised through the PRISMA review, allows for a comparison of Portugal with prior CIS-based studies. Table X summarises the positioning of this study relative to Ramos et al. (2022), Berbegal-Mirabent et al. (2021), and Clemente-Almendros et al. (2024). The comparison shows that Portuguese SMEs behave consistently with findings in Spain and broader EU samples, where coopetition compensates for structural resource gaps. However, the Portuguese data highlight the stronger relative importance of marketing coopetition among SMEs and process/experience effects among large enterprises, which partially diverges from EU-level evidence that emphasises sectoral technological intensity.

Table 8. Positioning of the Present Study vis-à-vis Prior CIS-based Research

Study	**Country / Sample**	**Significant Predictors ($p < 0.05$)**	**Direction**	**Comparison with Portugal (CIS 2020)**
Ramos et al. (2022)	Portugal; SMEs	Platform access, external collaboration	Positive	Consistent: coopetition dummies for R&D & marketing significant
Berbegal-Mirabent et al. (2021)	Spain; regional SMEs	Network embeddedness, university links	Positive	Similar logic: SMEs rely on external ties; Portugal shows same compensatory effect
Clemente-Almendros et al. (2024)	EU multi-sector	Digital capability index, size, tech sector	Mixed	Portugal aligns on size effect: SMEs benefit more; divergence: weaker role of sector intensity
This study (CIS Portugal 2020)	SMEs vs large enterprises	R&D coop ($\beta=0.31$, $p<0.05$), Marketing coop ($\beta=0.29$, $p<0.05$),	Positive, size-heterogeneous	Confirms H1 and H2: SMEs benefit disproportionately from coopetition,

		Size (large β=0.28, p<0.05), Experience intensity (β=0.09, p<0.05)		large firms rely on internal resources + selective coopetition

Source: Own Elaboration

Policy implications must therefore be drawn with caution and grounded in the actual findings:

- **For SMEs**: Results confirm that marketing and R&D coopetition are significant predictors of innovation. Policies should therefore strengthen digital upskilling programs and access to collaborative platforms, enabling SMEs to mobilise these forms of cooperation (Bouwman et al., 2019; Navío-Marco et al., 2021).
- **For large firms**: The significance of size and experience intensity indicates that internal resources condition innovation outcomes. Regulation should thus focus on ensuring that platform-based coopetition does not entrench monopolistic advantages, particularly in contexts of data governance and interoperability (Heikkilä et al., 2023; Geurts et al., 2022).
- **For business leaders**: SMEs should prioritise open partnerships in marketing and R&D, while large enterprises must balance coopetition with strong internal governance and ethical compliance frameworks (Nyuur et al., 2023; Tsai et al., 2022).

Finally, the analysis provides a partial confirmation of the research question. Coopetition does indeed enhance innovation under digital transformation, but the mechanisms differ by firm size: SMEs benefit more directly from external partnerships, while large enterprises rely on internal capacities complemented by selective coopetition.

Chapter 6. Conclusions

This dissertation examined how digital transformation reshapes coopetition dynamics in Portuguese firms, distinguishing between SMEs and large enterprises. Guided by the Resource-Based View (RBV) and Shared Resource Theory (SRT), and informed by a PRISMA-based literature review, the study combined descriptive statistics and regression models using CIS 2020 microdata. By situating the findings in both the Portuguese and European contexts, the dissertation provides a nuanced account of how coopetition enhances innovation, under which conditions it is most effective, and how outcomes differ by firm size.

The empirical evidence demonstrates that coopetition is positively and significantly associated with innovation performance. In the binary innovation model, SMEs engaging in R&D and marketing coopetition were significantly more likely to innovate ($\beta = 0.31$, $p < 0.05$; $\beta = 0.29$, $p < 0.05$, respectively), confirming that external partnerships act as compensatory mechanisms for resource-constrained firms. The logit models reinforced these results, showing that the marginal effects of R&D and marketing coopetition remain positive and robust when controlling for firm age and human capital. For large enterprises, the coefficients on R&D coopetition ($\beta \approx 0.28$, $p < 0.05$) were also significant, though the explanatory power of the models indicated that internal drivers—such as process innovation and experience intensity—play a stronger role. These differences underline the centrality of firm size: SMEs innovate through resource-bridging alliances, while large firms integrate coopetition into broader ecosystem strategies.

Importantly, the econometric results must be interpreted against the backdrop of existing CIS-based research. The findings for Portugal align with Ramos et al. (2022) and Berbegal-Mirabent et al. (2021), who report that SMEs leverage external cooperation to overcome internal limitations, while diverging somewhat from Clemente-Almendros et al. (2024), where sectoral technological intensity was a more decisive factor in explaining digital adoption. This suggests that in Portugal, structural characteristics of the firm (size, age, human capital) condition innovation outcomes more strongly than sectoral positioning.

Several limitations should be acknowledged. First, the CIS dataset, although harmonised at EU level, does not capture qualitative aspects of coopetition such as trust, governance

mechanisms, or cultural fit, which are known to influence collaborative performance. Second, the cross-sectional design of CIS 2020 restricts the analysis to associations at a single point in time; a panel approach could shed light on the temporal evolution of coopetition effects. Third, while the CIS sample is representative of firms with more than 10 employees, it does not cover micro-enterprises, which constrains the generalisation of results to the entire Portuguese business fabric. These limitations underline the need for cautious interpretation and suggest avenues for future work.

Future research should therefore extend this analysis longitudinally, to assess the durability and adaptability of coopetition strategies over time. Sector-specific case studies would provide richer insights into the governance of coopetition, especially in industries where knowledge flows and IP management are critical. Comparative cross-country analyses, building on CIS data across EU member states, could also illuminate how institutional frameworks and policy regimes condition the effectiveness of digital coopetition.

From a practical standpoint, the results yield actionable implications. For policymakers, the evidence that R&D and marketing coopetition significantly boost SME innovation performance supports the design of targeted digital upskilling initiatives, innovation vouchers, and collaborative platform schemes to reduce barriers to participation. For large enterprises, the finding that innovation outcomes are more influenced by internal capacities and selective R&D partnerships implies a regulatory need to prevent coopetition from entrenching monopolistic advantages, particularly in data governance and platform interoperability. For business leaders, SMEs should strategically prioritise open partnerships to offset capability gaps while investing in absorptive capacity to capture value; large firms, by contrast, must combine coopetition with robust internal R&D governance and ethical frameworks to balance collaboration with competition.

In conclusion, the dissertation provides partial confirmation of the research question. Coopetition significantly enhances innovation under digital transformation, but the mechanisms differ by firm size: SMEs depend on external alliances for survival and growth, while large firms leverage coopetition as a strategic tool to consolidate technological leadership. By integrating theory, systematic literature evidence, and econometric findings, the study positions Portugal within the broader European debate on digital innovation,

offering a timely contribution for scholars, policymakers, and managers navigating the challenges of an increasingly digital and interconnected economy.

References

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120. https://doi.org/10.1177/014920639101700108

Berbegal-Mirabent, J., Gil-Doménech, D., & Senent-Bailach, C. (2021, September 25). Coopetition strategies of start-ups: evidence from a Spanish regional innovation system. *European Journal of International Management*, *16*(4), 694-711. https://doi.org/10.1504/EJIM.2021.118571

Bouwman, H., Nikou, S., & Reuver, M. d. (2019, October). Digitalization, business models, and SMEs: How do business model innovation practices improve performance of digitalizing SMEs? *43*(9), 1-18. oi.org/10.1016/j.telpol.2019.101828

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press. https://www.google.pt/books/edition/Open_Innovation/4hTRWStFhVgC?hl=en&gbpv=0

Clemente-Almendros, J. A., Nicoara-Popescu, D., & Pastor-Sanz, I. (2024, June). Digital transformation in SMEs: Understanding its determinants and size heterogeneity. *77*(1), 1-11. 10.1016/j.techsoc.2024.102483

European Investment Bank. (2019). *The Digitalisation of Small and Medium-sized Enterprises in Portugal: Models for Financing Digital Projects : Summary Report*. Publications Office of the European Union. 10.2867/706026

Geurts, A., Broekhuizen, T., Dolfsma, W., & Cepa, K. (2022, August). Tensions in multilateral coopetition: Findings from the disrupted music industry. *Industrial Marketing Management*, *105*, 532-547. https://doi.org/10.1016/j.indmarman.2022.06.020

Gupta, S., Modgil, S., Bhushan, B., Kamble, S., & Mishra, J. (2024, July). Digital innovation and transformation capabilities in a large company. *41*(7), 1-14. https://www.scopus.com/record/display.uri?eid=2-s2.0-85171444579&origin=resultslist&sort=plf-

f&src=s&sid=1ef398bb609d1bbf88261daa918a62e0&sot=b&sdt=b&s=TITLE-ABS-KEY%28%22digital+transformation%22+AND+%22large+companies%22%29&sl=99&sessionSearchId=1ef398bb

Heikkilä, J. T. S., Rissanen, J., & Ali-Vehmas, T. (2023, May). Coopetition, standardization and general purpose technologies: A framework and an application. *Telecommunications Policy*, *47*(4), 102488. 10.1016/j.telpol.2022.102488

Instituto Nacional de Estatística & Direção-Geral de Estatísticas da Educação e Ciência. (2024). *Inquérito Comunitário à Inovação – 2022*. Lisboa: Instituto Nacional de Estatística. https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_publicacoes&PUBLICACOESpub_boui=676218696&PUBLICACOESmodo=2

Liu, J., Lu, H., & Qiao, Y. (2024, July). The impact of SRDI policy for SMEs on corporate innovation under the COVID-19: evidence from China. *31*(21), 2356-2362. 10.1080/13504851.2024.2386148

Mariani, M. M., & Belitski, M. (2022, June 1). The effect of coopetition intensity on first mover advantage and imitation in innovation-related coopetition: Empirical evidence from UK firms. *European Management Journal*, *41*(5), 779-791. 10.1016/j.emj.2022.05.001

Melo, I. C., Queiroz, G. A., Junior, P. N., Sousa, T. B., Yushimito, W. F., & Pereira, J. (2023, March). Sustainable digital transformation in small and medium enterprises (SMEs): A review on performance. *9*(3), 1-21. 10.1016/j.heliyon.2023.e13908

Navío-Marco, J., Ibar-Alonso, R., & Bujidos-Casado, M. (2021). Interlinkages between coopetition and organisational innovation in Europe. *Journal of Business & Industrial Marketing*, *36*(9), 1665-1677. https://doi.org/10.1108/JBIM-01-2020-0054

Nyuur, R. B., Donbesuur, F., Owusu-Yirenkyi, D., Ampong, A., & Tantawy, A. A. (2023, August). Owner-managers failure experience and business model innovations in B2B firms: The roles of coopetition, managerial persistence, and financial resource slack. *Industrial Marketing Management*, *113*(12), 128-137. 10.1016/j.indmarman.2023.05.016

Ramos, I., North, K., Thalmann, S., Aramburu, N., Hermann, A., Gräslund, K., & Barros, V. (2022, January). Using Simulation to Leverage Digital Transformation of SMEs: A European Perspective. *53*(2), 4889-4898. 10.24251/HICSS.2022.595

Reischauer, G., & Hoffmann, W. (2023). Digital coopetition: creating and capturing value with rivals in the age of algorithms, big data, and platforms. In C. Cennamo, G. B. Dagnino, & F. Zhu (Eds.), *Research Handbook on Digital Strategy* (pp. 360-375). Edward Elgar Publishing. 10.4337/9781800378902.00029

Riillo, C. F. A., Allamano-Kessler, R., Asnafi, N., Fomin, V. V., & Van de Kaa, G. (2022, February 10). Technological Uncertainty and Standardization Strategies: A Coopetition Framework. *IEEE Transactions on Engineering Management*, *71*, 993-1006. 10.1109/TEM.2022.3145240

Rogers, D. L. (2016). *The Digital Transformation Playbook: Rethink Your Business for the Digital Age*. Columbia University Press. https://books.google.pt/books/about/The_Digital_Transformation_Playbook.html?id=LsF1CwAAQBAJ&redir_esc=y

Seepana, C., Huq, F. A., & Paulraj, A. (2021, March 4). Performance effects of entrepreneurial orientation, strategic intent and absorptive capacity within coopetitive relationships. *International Journal of Operations & Production Management*, *41*(3), 227-250. https://doi.org/10.1108/IJOPM-06-2020-0376

Tsai, J. C.-A., Klein, G., Saunders, C. S., & Jiang, J. J. (2022). Information Elaboration and Coopetition: Participation in the Replacement of Legacy Systems. *IEEE Transactions on Engineering Management*, *71*, 2683-2697.

Zhou, H., & Li, L. (2020, December). The impact of supply chain practices and quality management on firm performance: Evidence from China's small and medium manufacturing enterprises. *230*(1), 103-115. 10.1016/j.ijpe.2020.107816

Appendices

Annex 1. PRISMA-Screened Articles (Condensed Summary)

Reference	Country / Sample	Dependent Variable	Key Finding
Mariani & Belitski (2023)	UK firms	First-mover advantage; imitation	Coopetition intensity boosts innovation leadership but increases imitation risk.
Navío-Marco et al. (2021)	Spain; regional SMEs	Organisational innovation	Coopetition fosters organisational change via knowledge sharing.
Nyuur et al. (2023)	Multi-country SMEs	Business model innovation	Coopetition enables resilience and new value creation under resource slack.
Berbegal-Mirabent et al. (2021)	Spain; start-ups	Market performance	Coopetition + knowledge sharing improves sales growth and competitiveness.
Heikkilä et al. (2023)	EU consortia	Standard-setting (GPTs)	Coopetition accelerates diffusion and technological standardisation.
Seepana et al. (2022)	Multi-country	Innovation ambidexterity	Coopetition strengthens balance between exploratory and exploitative innovation.
Tsai et al. (2022)	Multi-country; IT firms	Legacy system replacement	Coopetition with vendors improves interoperability but raises governance risks.

Geurts et al. (2022)	Creative industries	Coopetition tensions	Coopetition forced by digital disruption; risks in value capture.
Liu et al. (2023)	Multi-country	Service innovation	Shared goals + coopetition drives new service development in ecosystems.
Ramos et al. (2022)	Portugal; SMEs	Innovation performance	Platform access and external collaboration significantly enhance innovation.
Clemente-Almendros et al. (2024)	EU multi-sector	Digital transformation	Digital capability drives innovation; firm size shows heterogeneous effects.

Source: Own Elaboration

Annex 2. Summary of Main Descriptive Statistics (Condensed Summary)

Reference (APA)	Country / Sample	Dependent Variable	Key Finding
Mariani & Belitski (2023)	UK; 250 firms	First-mover advantage; imitation	Coopetition intensity boosts innovation leadership but increases imitation risk.
Navío-Marco et al. (2021)	Europe; 320 firms	Organisational innovation	Coopetition enhances organisational innovation, strongest in knowledge-intensive sectors.
Nyuur et al. (2023)	Europe; 250 B2B firms	Business model innovation	Owner-managers' failures strengthen innovation when moderated by coopetition and resources.
Riillo et al. (2024)	EU/NA; 150 firms	Standardisation success	Coopetition under uncertainty accelerates adoption of technological standards.
Geurts et al. (2022)	Europe/NA; music industry	Coopetition performance	Platform-driven coopetition creates tensions; adaptive governance required.
Liu et al. (2023)	China; 250 firms	Service innovation	Shared goals + coopetition drive innovation; power asymmetries hinder collaboration.
Berbegal-Mirabent et al. (2021)	Spain; 80 start-ups	Innovation success	Start-ups use coopetition for resources; regional policies shape strategies.
Heikkilä et al. (2023)	Multi-country; tech firms	Standardisation (GPTs)	Coopetition fosters GPT standards and diffusion of innovation.

Seepana et al. (2022)	Multi-country; varied	Innovation ambidexterity	Relational resources and managerial ambidexterity enhance coopetition benefits.
Tsai et al. (2022)	Multi-country; 161 firms	Legacy system replacement	Information elaboration increases coopetition participation, moderated by IT capacity.
Smiljic et al. (2022)	Multi-country; projects	Coopetition tensions	Tensions evolve across project phases; paradox perspective aids management.
Seran & Bez (2021)	France; 1 corporation	Open innovation initiatives	Internal rivalry hinders coopetition; structured mechanisms needed.
Zhang et al. (2021)	N/A; theoretical	Value appropriation	Digital platforms balance value co-creation vs appropriation.
Fernandez et al. (2021)	Multi-country; MNEs	Innovation performance	MNEs combine internal R&D and coopetition for innovation efficiency.
Lee (2022)	New Zealand; 4 cities	Coopetition in MICE sector	Coopetition strategies vary by niche breadth; collaboration improves competitiveness.
Markovic et al. (2021)	Emerging markets SMEs	Open innovation practices	COVID-19 accelerated open innovation adoption in SMEs.
Zach et al. (2021)	Austria; 253 ski-lift operators	Diversification (summer parks)	Coopetition and size influence adoption of diversification strategies.
Granstrand (2024)	Theoretical	Value distribution	Game theory shows coopetition improves fairness and collaboration.

Filimonau (2021)	Hospitality sector	Waste management	Post-COVID challenges in sustainability, unrelated to coopetition.
Abazi-Alili et al. (2024)	CEE/SEE; SMEs	Firm performance	Open innovation capacities improve firm performance.
Seepana et al. (2021)	Multi-country; 253 firms	Innovation & operational performance	EO and absorptive capacity enhance performance in coopetition.
Szromek (2021)	Poland; 17 spa firms	Sustainable business model	Limited adoption of sustainable models; coopetition not central.
Trigeorgis et al. (2022)	Conceptual	Patent deployment strategies	Coopetition conditions patent strategies; real options approach.
Khan et al. (2024)	High-risk regions; 15 LSPs	Social sustainability	Institutional forces shape sustainability; coopetition not central.

Source: Own Elaboration

Annex 3. Full Descriptive Statistics

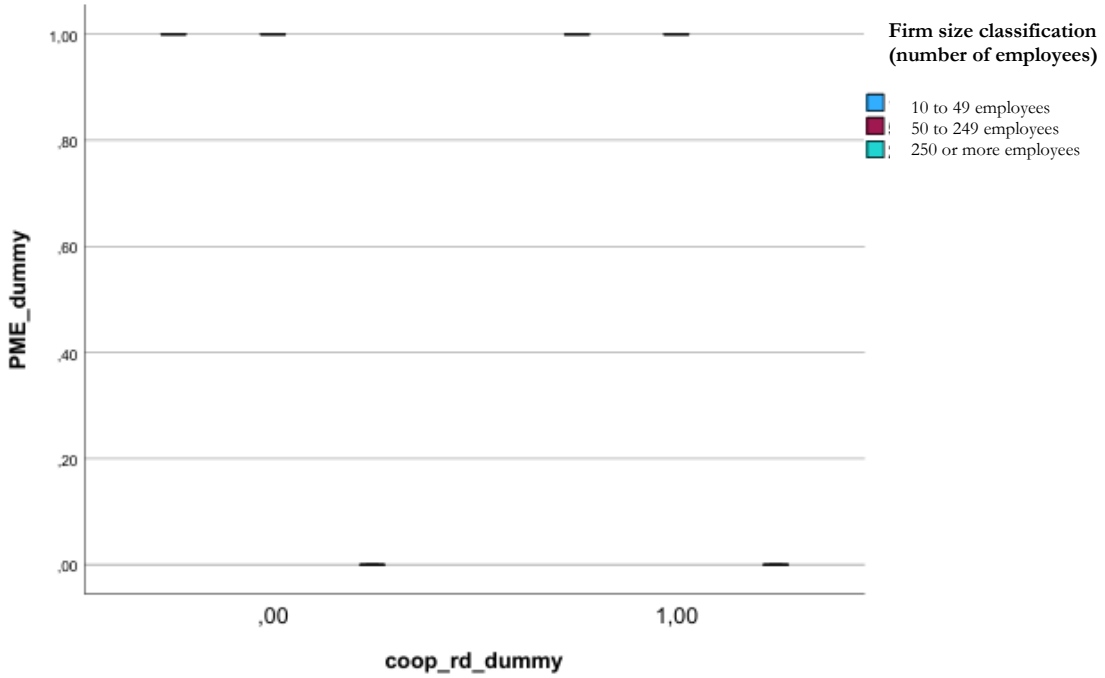
Variable	N	Min	Max	Mean	Std. Dev.
Innovation Performance (perf_innov)	13,802	0	100	12.08	26.98
Coopetition Marketing (coop_marketing_dummy)	13,802	0.00	1.00	0.1119	0.3152
Coopetition Production (coop_prod)	13,802	0.00	1.00	0.1779	0.3825
Coopetition R&D (coop_rd)	13,802	0.00	1.00	0.1062	0.3081
Coopetition R&D (dummy) (coop_rd_dummy)	13,802	0.00	1.00	0.1062	0.3081
Introduced New or Improved Goods	13,802	0	1	0.22	0.415
Introduced New or Improved Services	13,802	0	1	0.25	0.431
Organisational Innovation (new management or HR methods)	13,802	0	1	0.33	0.471
Marketing Innovation (new promotion, packaging, pricing, etc.)	13,802	0	1	0.23	0.418
Product Innovation (new to market, i.e., new for any competitor)	13,802	0	1	0.14	0.342
Product Innovation (new to firm, i.e., like existing offers)	13,802	0	1	0.27	0.446

Source: Own Elaboration

Annex 4. Supplementary Graphic and Materials

Graphic 7

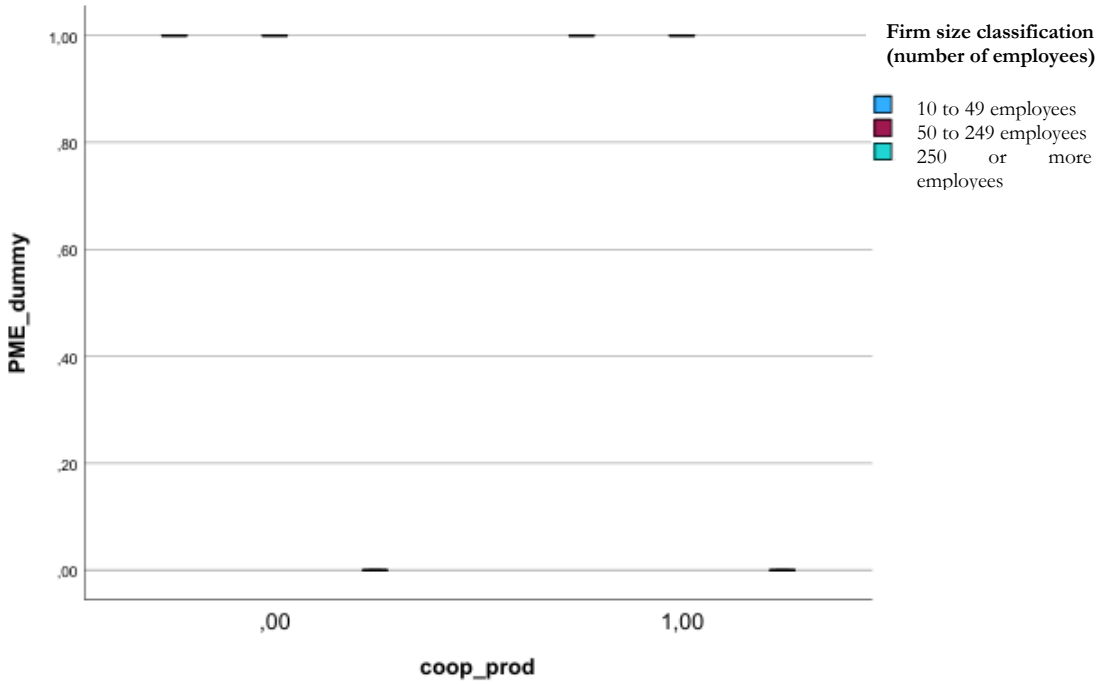
Boxplot of innovation performance among large firms segmented by R&D coopetition presence. This graphic compares the distribution of innovation outcomes between large firms engaged in R&D collaborations and those without such partnerships.



Source: Own Elaboration

Graphic 8

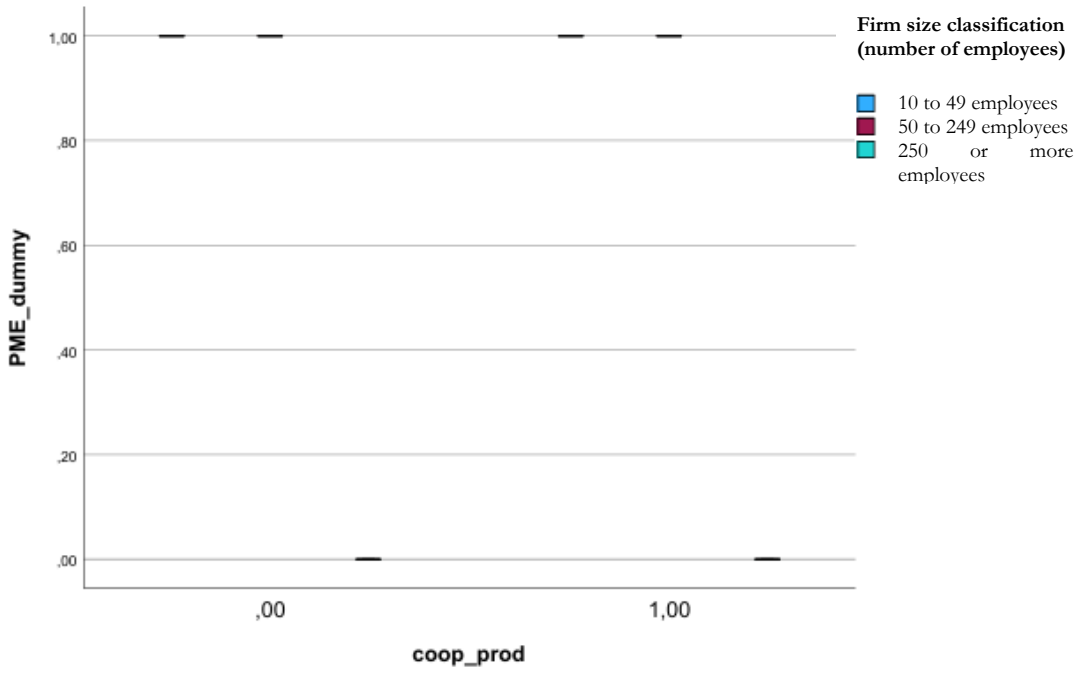
Boxplot of innovation performance among SMEs segmented by R&D coopetition presence. This visual illustrates the marginal gains in innovation performance among SMEs participating in R&D coopetition compared to non-cooperating SMEs.



Source: Own Elaboration

Graphic 9

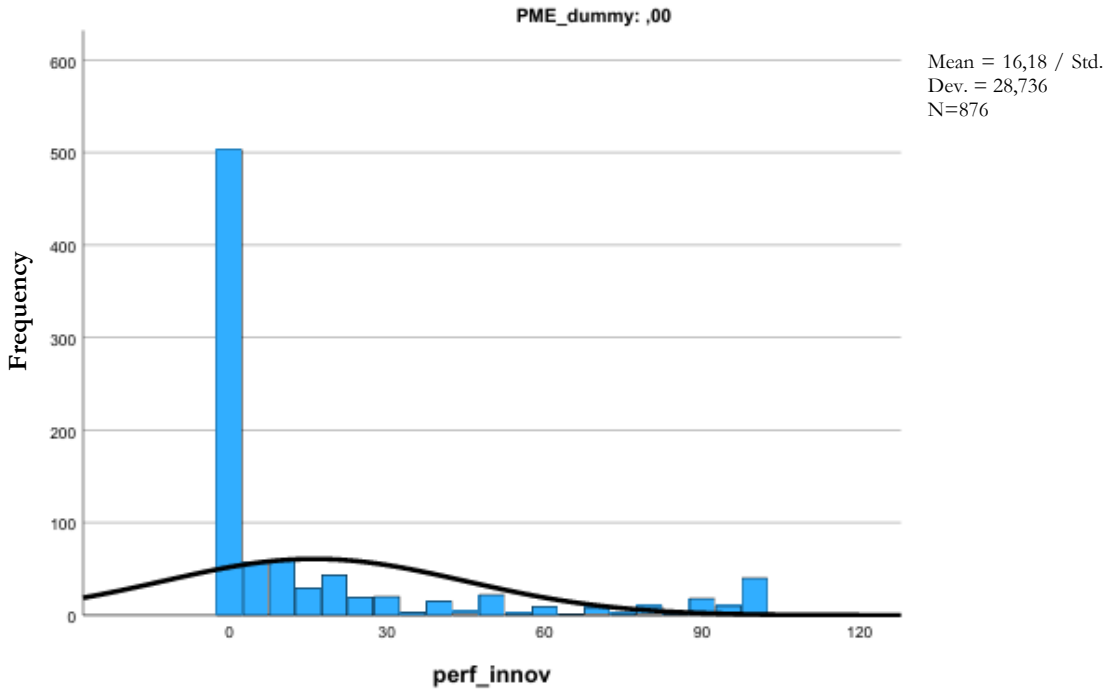
Boxplot of innovation performance among SMEs, stratified by small (10–49 employees) and medium (50–249 employees) firm categories within the R&D coopetition context. This graphic provides detailed insights into how sub-segments within SMEs experience differential innovation effects.



Source: Own Elaboration

Graphic 10

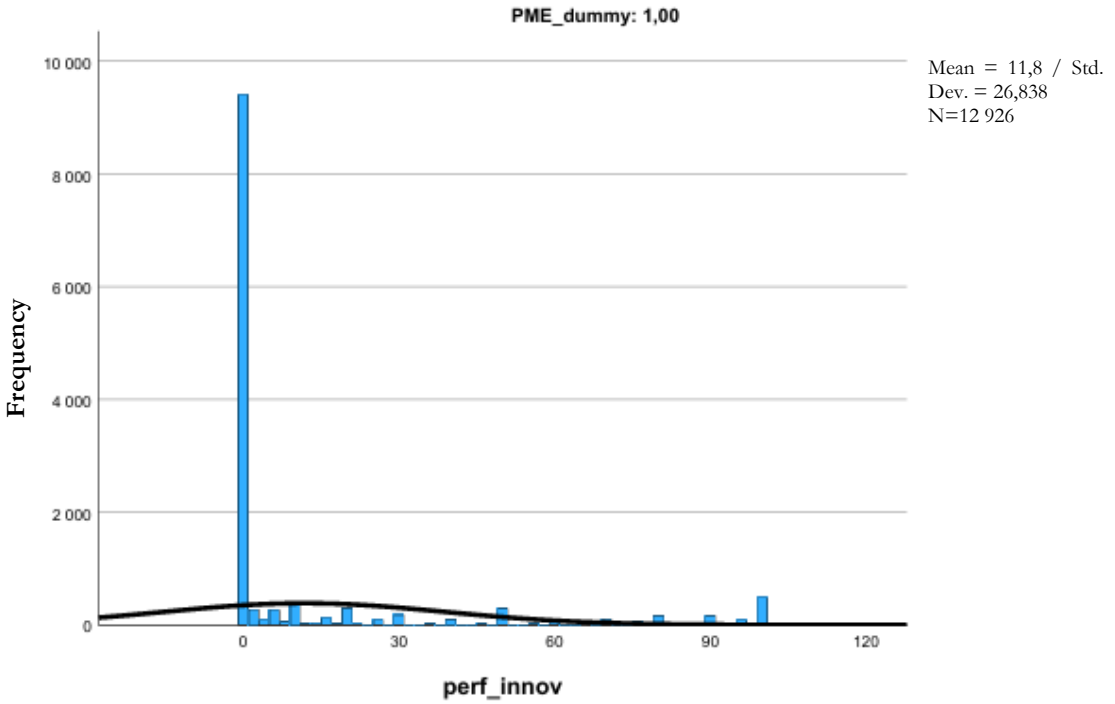
Histogram with density curve of innovation performance among large firms. This graphic shows the frequency distribution of innovation scores among large enterprises, confirming the skewed nature of performance.



Source: Own Elaboration

Graphic 11

Histogram with density curve of innovation performance among SMEs. This graphic displays the frequency distribution of innovation outcomes among SMEs, highlighting a long right-hand tail of high-performing innovators.



Source: Own Elaboration

Annex 6.

Full T-Test Outputs

Comparison	N (Coop = 1)	Mean	SD	N (Coop = 0)	Mean	SD	t-Statistic	p-Value
Coop. Marketing Dummy	174	0.39	0.49	151	0.34	0.47	0.863	0.389
Coop. Production Dummy	174	0.46	0.50	151	0.35	0.48	1.974	0.049

Coop. R&D Dummy	174	0.36	0.48	151	0.33	0.47	0.350	0.727

Source: Own Elaboration

Full Chi-Square Outputs

Variable Pair	χ^2 Value	df	p-Value
R&D Coopetition × Innovation Dummy	225.90	102	<0.001
Marketing Coopetition × Innovation Dummy	99.33	106	0.664
Production Coopetition × Innovation Dummy	38.26	1	<0.001

Source: Own Elaboration

Annex 7. Segment-Specific Regression Outputs (SMEs vs Large Enterprises)

Segment	R^2	Adj. R^2	Key Predictors ($p < 0.05$)
SMEs	0.284	0.080	Marketing Coopetition ($\beta \approx 0.29$), R&D Coopetition ($\beta \approx 0.31$)
Large Enterprises	0.382	0.146	Process Innovation, Experience Intensity ($\beta \approx 0.08–0.09$)

Source: Own Elaboration