
PE ownership during the COVID-19 Pandemic: A blessing or a curse

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Throughout my master's degree, I have had the opportunity to enhance both my hard and soft skills while deepening my knowledge in finance. This journey has also been a process of self-discovery, helping me better understand who I am and the professional path I aspire to pursue. Therefore, I would like to express my gratitude to the professors, faculty staff, and my friends who were part of my academic journey.

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Abstract

The COVID-19 pandemic was a period marked by significant economic challenges and uncertainty. While some research has studied how Private Equity (PE)-backed companies navigate such crises, most studies focus on major markets, leaving smaller economies underexplored. In particular, Portugal's PE sector remains understudied, even more so regarding the impact of the COVID-19 negative shock and the subsequent recovery on the performance of these firms. Therefore, this research aims to fill this gap in the literature by studying the operating performance of PE portfolio companies in small economies, like Portugal, during and after the COVID-19 pandemic.

To achieve such a goal, this research compares the operating performance of PE-backed companies with that of non-PE-backed companies before, during, and after the COVID-19 pandemic.

Performance indicators such as sales, assets, employment, and earnings were used to address the performance of PE portfolio companies using a differences-in-differences (DiD) model, with non-PE portfolio companies as the control group. Propensity Score Matching (PSM) was used to match target and control firms to ensure the validity of the baseline results.

The results indicate that, across all firm performance metrics, PE-backed firms tend to underperform compared to their peers or, at best, fail to show any statistically significant advantage. These findings contrast with those from major markets, underscoring the importance of studying smaller or less-developed markets to gain a more comprehensive understanding of PE's impact.

Key Words: Private Equity Buyouts, Firm Performance, COVID-19 Pandemic

JEL-Codes: G01, G23, G32, G34

Resumo

A pandemia COVID-19 foi um período marcado por desafios económicos significativos e incertezas. Embora alguns estudos tenham estudado como as empresas detidas por *Private Equity* (PE) lidam com as crises, a maioria dos estudos concentra-se nos principais mercados, deixando as economias mais pequenas pouco exploradas. Em particular, o setor de PE em Portugal mantém-se pouco explorado, ainda mais no que concerne ao impacto do choque negativo da COVID-19 e à subsequente recuperação no desempenho destas empresas. Desta feita, este estudo pretende colmatar esta lacuna existente na literatura através do estudo do desempenho operacional das empresas dos portfólios de PE em economias pequenas, como Portugal, durante e após a pandemia COVID-19.

Para alcançar tal objetivo, este estudo compara o desempenho operacional de empresas detidas por PE com o de empresas não detidas por PE antes, durante e após a pandemia COVID-19.

Indicadores de desempenho como vendas, ativos, emprego e lucros foram usados para abordar o desempenho das empresas detidas por PE, utilizando um modelo de diferenças em diferenças (DiD), com empresas não detidas por PE como grupo de controlo. O *Propensity Score Matching* (PSM) foi utilizado para criar as correspondências entre as empresas alvo e de controlo, para garantir a validade dos resultados de linha da base.

Os resultados demonstram que, em todas as métricas de desempenho das empresas, as empresas detidas por fundos de PE tendem a ter um desempenho inferior em comparação com empresas semelhantes, ou, na melhor das hipóteses, não apresentam qualquer vantagem estatisticamente significativa. Estes resultados contrastam com os dos principais mercados, sublinhando a importância de estudar mercados mais pequenos ou menos desenvolvidos para obter uma compreensão mais abrangente do impacto do PE.

Palavras-chave: Aquisições de *Private Equity*, Desempenho da Empresa, Pandemia COVID-19

Códigos JEL: G01, G23, G32, G34

Index

Acknowledgements.....	i
Abstract	ii
Resumo	iii
Index of Equations.....	vi
Index of Figures.....	vi
Index of Tables	vii
Acronyms and Abbreviations.....	viii
1. Introduction.....	1
2. Literature Review	4
2.1. Private Equity Definition.....	4
2.2. Private Equity Waves and Evolution	5
2.3. Private Equity in Portugal.....	7
2.4. Sources of Value Creation.....	9
2.5. Empirical Evidence	10
2.5.1. Private Equity Impact on Its Portfolio Companies Through Time	10
2.5.2. Private Equity Impact on Its Portfolio Companies During Crisis Periods....	13
3. Methodology and Sample Collection	15
3.1. Methodology	15
3.2. Sample Selection	17
3.3. Control Sample	20
3.4. Descriptive Statistics.....	21
3.4.1. Pandemic Impact on PE Portfolio Companies' Performance	21
3.4.2. Performance Recovery of PE Portfolio Companies from the Pandemic.....	25
3.4.3. Pre- and Post-Pandemic Performance Comparison of PE Portfolio Companies.....	30

4. Results.....	34
4.1. Pandemic Impact on PE Portfolio Companies' Performance.....	34
4.2. Performance Recovery of PE Portfolio Companies from the Pandemic.....	35
4.3. Pre- and Post-Pandemic Performance Comparison of PE Portfolio Companies	37
4.4. Robustness Check.....	38
4.4.1. Pandemic Impact on PE Portfolio Companies' Performance	43
4.4.2. Performance Recovery of PE Portfolio Companies from the Pandemic.....	44
4.4.3. Pre- and Post-Pandemic Performance Comparison of PE Portfolio Companies	45
References	48
Appendix A – Samples (PE-backed and Control companies) comparison with robustness check.....	53

Index of Equations

Equation (3.1)	16
Equation (3.2)	17
Equation (3.3)	24

Index of Figures

Figure 1 - Evolution of risk capital AuM, in Portugal (€ million) (2017-2023)	7
Figure 2 - Evolution of risk capital firms and funds, in Portugal (2017-2023).....	8
Figure 3 - Effect of PE ownership on firm performance during the COVID-19 pandemic (sample of the first research question)	25
Figure 4 - Effect of PE ownership on firm performance during the post-COVID-19 pandemic (sample of the second research question)	29
Figure 5 - Effect of PE ownership on firm performance during the post-COVID-19 pandemic (sample of the third research question)	33
Figure 6 - Effect of PE ownership on firm performance during the COVID-19 pandemic (sample of the first research question with robustness check)	40
Figure 7 - Effect of PE ownership on firm performance during the post-COVID-19 pandemic (sample of the second research question with robustness check)	41
Figure 8 - Effect of PE ownership on firm performance during the post-COVID-19 pandemic (sample of the third research question with robustness check)	42

Index of Tables

Table 1 - Sample selection summary	19
Table 2 - Characteristics of PE and control samples in 2019 (sample of the first research question)	22
Table 3 - Characteristics of pre-pandemic and during pandemic samples (sample of the first research question).....	23
Table 4 - Characteristics of PE and control samples in 2021 (sample of the second research question)	26
Table 5 - Characteristics of during pandemic and post-pandemic samples (sample of the second research question)	28
Table 6 - Characteristics of PE and control samples in 2019 (sample of the third research question)	31
Table 7 - Characteristics of pre-pandemic and post-pandemic samples (sample of the third research question).....	32
Table 8 - Firm performance during the pandemic	34
Table 9 - Firm performance during the post-pandemic	36
Table 10 - Firm performance during the post-pandemic	37
Table 11 - Firm performance during the pandemic (with robustness check)	43
Table 12 - Firm performance during the post-pandemic (with robustness check)	44
Table 13 - Firm performance during the post-pandemic (with robustness check)	45

Acronyms and Abbreviations

AuM	Assets under Management
CAGR	Compound Annual Growth
DiD	Differences-in-differences
EBIT	Earnings before Interest and Taxes
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization
GFC	Global Financial Crisis
GPs	General Partners
IPO	Initial Public Offering
LBOs	Leveraged buyouts
LPs	Limited Partners
MBIs	Management buy-ins
MBOs	Management buyouts
PE	Private Equity
PSM	Propensity Score Matching
Q1	First research question
Q2	Second research question
Q3	Third research question
QE	Quantitative Easing
ROA	Return-on-Assets
ROCE	Return on Capital Employed
ROE	Return-on-Equity
ROS	Return-on-Sales
UK	United Kingdom
US	United States
VC	Venture Capital

1. Introduction

Over the last decades, the Private Equity (PE) industry has experienced significant growth (Díaz et al., 2025), playing a crucial role in enhancing the productivity and competitiveness of its investee companies, contributing significantly to economic growth and the broader global economy (Frontier Economics, 2013). Nowadays, PE serves as a critical element in the portfolios of institutional investors, representing a key asset class within alternative investments (Díaz et al., 2025).

Actually, the evolution of PE has been shaped by distinct waves (Matsumura & Shimizu, 2010), with the first in the 1980s and the second emerging in the late 1990s (Hoskisson et al., 2013). Subsequently, the 2010s saw a surge in PE activity driven by expansionary monetary policies, low interest rates, and liquidity, which fuelled operational improvements in portfolio companies (Manac et al., 2022). Afterwards, during the post-COVID-19 pandemic, rising interests led to a downturn in dealmaking, exits, and fundraising, highlighting cash flow constraints for Limited Partners (LPs) (MacArthur et al., 2024). Nevertheless, in 2024, Europe observed an increase in its deal activity when compared to 2023 (EY, 2025), which can indicate that this sector's activity may be improving.

The evolution of the PE sector has prompted researchers to investigate more closely the influence of PE companies on the firms in which they invest. They mainly use benchmarks for their studies, such as the S&P 500 or control groups composed of comparable companies that are not backed by PE funds. Generally, it is concluded that PE-backed firms outperform their comparable companies (Kaplan & Strömberg, 2009; Achleitner et al., 2010, 2011; Wilson et al., 2012; Bernstein et al., 2020; Lavery & Wilson, 2024a; Lavery et al., 2024) and also the S&P 500 (Higson & Stucke, 2012; Brown & Kaplan, 2019; Gruener & Marburger, 2022), mainly when regarding analysis focused on the United States (US) and the United Kingdom (UK). Contrarily, when studying other countries in which the PE is not firmly established, negative impacts of PE ownership are concluded when compared with non-PE portfolio companies (Vinten, 2007; Mendes & Sousa, 2013).

Although the growth of PE activity has been a phenomenon, the research being done is mainly focused on the main markets. Consequently, Portugal is not a well-studied and analyzed market, even though the PE sector presents an increasingly important role in this country's economy. More specifically, in Portugal, from 2017 to 2023, risk capital Assets

under Management (AuM) more than doubled while presenting a significant positive evolution of the number of funds (CMVM, 2023).

Alongside this portent, the COVID-19 pandemic, which took place at the beginning of 2020, had a very impactful effect on the worldwide economy, with the PE market not being an exception. It brought unprecedented disruption to the global economy, seriously affecting several sectors around the world, including in Portugal. Consequently, as the majority of PE performance studies are focused on countries in which the PE sector is well developed and more firmly established, as in the case of the US and the UK, there is a lack of studies involving smaller countries, specifically, Portugal. Moreover, PE performance studies focused on the recent crisis are also scarce. Therefore, this research seeks to fill some important gaps in the literature, providing a practical understanding of the PE sector in Portugal, especially in the context of the pandemic crisis.

As a result, the main purpose of this study lies in gathering both issues due to their importance and relevance in the economic world. In this way, it will be analyzed how the Portuguese PE portfolio companies performed during the COVID-19 period and how their recovery was after it, comparing also the performance before and after the COVID-19 pandemic. Thus, this research aims to understand if PE companies were able to deal, in operating terms, better with the pandemic challenges when contrasted with comparable companies that did not have this support, comprehending, in consequence, whether the resilience shown, historically, by PE also took place during the COVID-19 pandemic (Arundale & Mason, 2020).

This research will consist of an analysis of all the Portuguese companies acquired by PE firms before December 2017 that were still portfolio companies by the end of 2021. Furthermore, to study the recovery of those companies, this research will also include a sample of companies that were acquired before December 2021 and remained under PE ownership by the end of 2023. Additionally, to study the recovery from pre- to post-pandemic performance levels, a study will be conducted using only the sub-sample of companies acquired before December 2017 and still in the portfolio by 2023.

Consequently, this study will contribute academically, providing new insights and adding new empirical data on companies' performance during this exogenous shock, which was the pandemic crisis, complementing studies carried out in larger markets such as the US and the UK. Alongside, it will also contribute practically, whether for investors or PE fund managers, helping to formulate future investment strategies during times of uncertainty, and

for entrepreneurs who seek to understand how PE can positively impact overcoming crisis periods.

The remainder of this dissertation is structured as follows. Chapter 2 presents a review of the existing and relevant literature focused on PE, especially emphasizing the Portuguese framework. Chapter 3 describes the methodology and data sample collection process regarding both target and control samples, presenting a sample description. Chapter 4 presents the results of the study through multivariate analysis, ensuring their reliability through robustness checks. Finally, Chapter 5 closes this report by discussing the main conclusions and limitations of this study and future research.

2. Literature Review

2.1. Private Equity Definition

PE plays an important role in its backed companies since it both improves the productivity of its investee companies and enhances their competitiveness, which subsequently impacts economic growth significantly and, thus, the global economy (Frontier Economics, 2013).

Actually, PE serves as a financing option for companies that are considered too risky for other financing options, such as bank loans or public equity. Therefore, PE investors are willing to take the time to comprehend the associated risks and influence management in return for their capital (Fried 1999). Furthermore, PE is an equity or near-equity investment in securities not publicly traded (Fried, 1999; Schneeweis et al., 2008; Wood & Wright, 2009; Demaria, 2013), where the investor takes on significant risk in exchange for potential long-term capital appreciation (Fried, 1999), obtaining majority control of an existing or mature company (Kaplan & Strömberg, 2009). This differentiates Venture Capital (VC) from PE since the first one typically invests in companies that are emerging and present youth and commonly take partial equity and board control, not buying majority control (Kaplan & Strömberg, 2009; Breuer & Pinkwart, 2018)

PE investment strategies focus on achieving higher long-term returns than public companies by tapping into the market of privately held businesses and actively shaping the management and operations of those companies in which they invest. (Schneeweis et al., 2008). Specifically, PE includes investments such as management buyouts (MBOs), leveraged buyouts (LBOs), and management buy-ins (MBIs) (Wood & Wright, 2009; Mendes & Sousa, 2013)

In fact, PE funds are managed by specialized firms (Schneeweis et al., 2008) and are usually organized as LPs, which are external investors. LPs can encompass institutional investors such as pension funds, investment funds, endowment funds, banks, sovereign wealth funds, and high net worth individuals, along with funds of funds. The designation “LPs” reflects that their total liability is limited to their investment amount. Distinctly, General Partners (GPs) are the PE fund managers, who have possibly unlimited liability for the funds’ actions. They invest alongside the other institutional and individual investors in the PE fund (Gilligan & Wright, 2014).

Furthermore, whereas PE funds intend to extract profitability from the sale of the investments, GPs, apart from the salary and the returns they receive as investors, also have two additional income sources: fee income and carried interest. GPs earn management fees corresponding to a percentage of the raised funds. Thus, the fee income is proportional to the fund's dimension. The carried interest usually corresponds to a share of the fund's profits, equalizing, commonly, 20% (Gilligan & Wright, 2014).

Finally, PE investments are characterized by being an illiquid asset class (Burdel, 2009) and also by their risk, often requiring extended holding periods to achieve the desired returns (Popp et al., 2018). Consequently, the investment period is frequently from 4 to 7 years (Popp et al., 2018) and may extend as long as 8 to 10 years (Schneeweis et al., 2008). Furthermore, PE funds present a usual built-in horizon of 10 to 12 years (Burdel, 2009), considering that specifically, this predetermined lifespan is usually 10 years plus a 2-year extension (Gilligan & Wright, 2014). Additionally, it is worth mentioning that, possibly, due to the competition increasing in Europe's PE market, the average holding periods of PE acquisitions in this continent have been growing (Joenväärä et al., 2022) and have persisted in increasing in 2024 (EY, 2025).

2.2. Private Equity Waves and Evolution

A continuous dialogue has been occurring regarding the importance of PE in the economy (Brown et al., 2020).

Alongside a privatization wave worldwide observed (Matsumura & Shimizu, 2010), during the 1980s, emerged the first PE firm transactions wave (Hoskisson et al., 2013), which was eclipsing the public corporation. Actually, the development of more liquid capital markets alongside a great emergence of the PE industry ended in positive progress (Toms et al., 2015). Though it was followed by a recession that culminated in this industry's first main correction (Brown et al., 2020). Nonetheless, this wave was marked by unsuccessful investments since almost a third of the ones that occurred in the latter half of the 1980s presented disappointing returns for the LPs. Although this was a great event, the deals that happened after the '80s were less leveraged than the ones that took place during this wave (Brown et al., 2020).

Subsequently, the second great wave started in the latest 1990s and emerged during the 2000s beginnings due to the low cost of capital (Hoskisson et al., 2013), having peaked

alongside the large transactions that took place in 2006 and 2007, and collapsed during the Global Financial Crisis (GFC) in 2008 (Brown et al., 2020). During this wave, PE firms adopted a strategy that intended an international diversification of the fund (Toms et al., 2015). In this way, it is also relevant to differentiate these two first waves. While in the first wave, the focus was on creating firm value through cost-cutting procedures, in the second wave, PE firms' attention was more concentrated on creating firm value and profitability through the provision of professional managerial support (Hoskisson et al., 2013).

Then, during the 2010s, a rise in PE activity was observed (Brown et al., 2020). This post-financial crisis period was characterized by an expansionary monetary policy enacted by the central banks, which presented substantial liquidity, exhibiting low interest rates, regarding the incorporation of uncommon measures such as Quantitative Easing (QE) (Manac et al., 2022). This can incentivize PE firms to follow operational improvement in their backed companies regarding the advantageous moment, motivating, as a result, this sector's development. These events, alongside a steady growth economy and low inflation, presented the potential to boost PE activity (Aryoubi et al., 2020). Moreover, this was even more emphasized by the significant purchasing power that the PE firms presented during this period, after all the process undergone by the PE industry (Brown et al., 2020).

Nevertheless, the rapid interest rate rise that took place in the post-COVID-19 pandemic led to sharp declines in the activity of this sector, comprising dealmaking, exits, and also fundraising. Consequently, in 2023, the lowest annual amount raised by this sector since 2018 was observed, reflecting the cash flow constraints being faced by LPs (MacArthur et al., 2024). Additionally, before the COVID-19 pandemic, financial sponsors were paying high transaction prices. Thus, dry powder could have played an important role in the recovery from this event (Brown et al., 2020). With capital available in reserve, PE firms could have taken advantage of opportunities created by reduced investment estimates, financial difficulties in target companies, or even the need for capital in the market, which would warrant the creation or at least preservation of value during the recovery period. Hence, analyzing these recent events, there is a reason to believe that this sector's activity can be nearing, or possibly exceeding, the consistent growth wave set in the 2010s.

Currently, as the spotlight is all focused on sustainability, PE is not an exception in this context. The social factor has been increasingly present in PE portfolios due to the significant pressure related to how they measure and approach their investment responsibilities, even more intensified after the COVID-19 pandemic. Consequently, ESG-

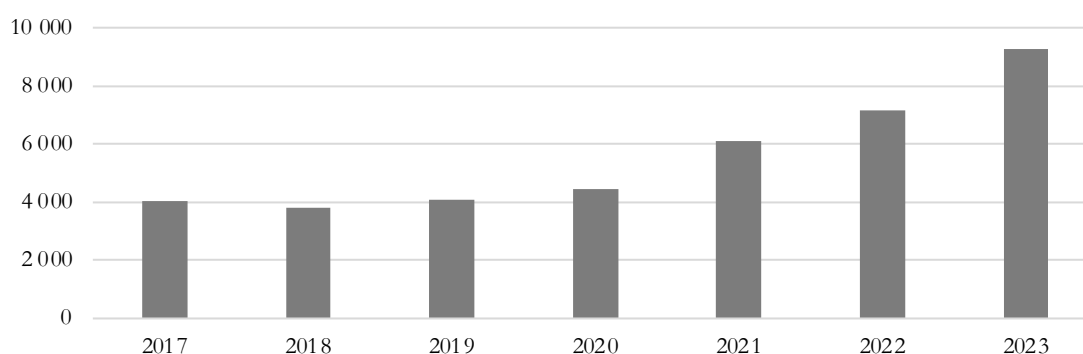
focused investments can be part of PE firms’ strategies through the adoption of these principles in the industry and the integration of ESG considerations into the investment processes (Andrews et al., 2022). Furthermore, the increase in PE firms’ ESG disclosures that is being observed enhances the commitment to sustainability (Abraham et al., 2024).

2.3. Private Equity in Portugal

Over the last few years, the risk capital in Portugal has been on a growth trend, not only in the amount of AuM but also in the number of alternative investment undertakings of risk capital¹, which exhibited a particular rise from 2021 to 2023, even though it stabilized in 2023 (CMVM, 2023).

Regarding the Portuguese framework, a contextualization of national regularization changes during recent years is crucial. Relevantly, the entry into force of the *Regime da Gestão de Ativos* (“Asset Management Regime”), in 2023, reinforced the responsibilities of the different market participants. This was particularly focused on management entities, due to the improvement of the flexibility in *ex-ante* supervision mechanisms alongside the strengthening of the *ex-post* supervisory approach (CMVM, 2023). In Figure 1², it can be observed that the risk capital in Portugal has been growing full steam ahead. From 2017 to 2023, the risk capital AuM more than doubled through consistent growth (CMVM, 2024). Although the interest rates have increased in recent years, namely 2022 and 2023 (BPstat, 2025), the risk capital AuM increased by 52% from 2021 to 2023 (CMVM, 2024).

Figure 1 - Evolution of risk capital AuM, in Portugal (€ million) (2017-2023)



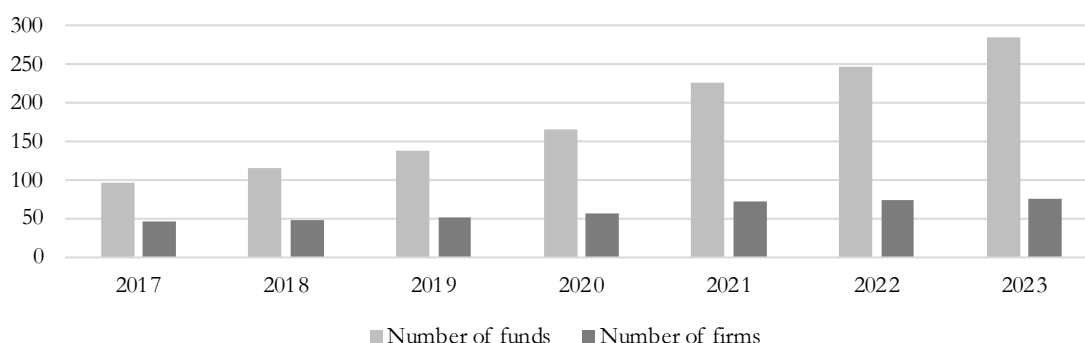
Source: CMVM, 2024

¹ The Portuguese term "*capital de risco*", which encompasses both PE and VC, can be translated as “venture capital”. However, to mitigate any potential confusion, “risk capital” will be utilized as a more literal translation.

² This analysis of CMVM (2024), does not include the results respecting the year 2024 since CMVM has not yet, until the 16th of May 2025, published the statistics including the full year of 2024.

Another development that can be noted regards the distinct evolution of the number of funds and firms in this market. As observed in Figure 2³, although the number of risk capital firms has been relatively constant from 2017 to 2022, the evolution of the number of funds is remarkable (CMVM, 2024). Actually, it increased almost threefold, which demonstrates the competitiveness improvement of this market.

Figure 2 - Evolution of risk capital firms and funds, in Portugal (2017-2023)



Source: CMVM, 2024

When analyzing the presence of VC and PE in the Portuguese market, it is settled that the current majority of risk capital AuM respects PE since 67% of the risk capital AuM is PE type, whereas only 28% is VC type (CMVM, 2023).

Nonetheless, when examining the interest period of this dissertation, a careful approach is recommended due to the meticulous reference period regarding the COVID-19 pandemic, which impacted the worldwide economy. Because of this event, Portugal presented a *Plano de Recuperação e Resiliência* (“Recovery and Resilience Facility”) to be employed by *Banco Português de Fomento, S.A.*. This comes partially alongside the Government’s commitment to implementing a relevant reform concerning business capitalization and financial resilience, intended to be applied as capital injections for the companies most affected by the pandemic. In a nutshell, this enhances the essential role of risk capital in these economic recovery periods (CMVM, 2020).

Finally, it is also important to note that in 2024, the Iberian Peninsula, in which Portugal is included along with Spain, presented a decline (of 16%) from 2023 in the PE deal activity, contrary to the European PE market (which presented an increase of approximately 5%), indicating that the Iberian market is below the European average. Specifically, it is noteworthy that even though this contrast of the Portuguese and European PE deal activity,

³ This analysis of CMVM (2024), does not include the results respecting the year 2024 since CMVM has not yet, until the 16th of May 2025, published the statistics including the full year of 2024.

the various stages of the lifecycle of the major PE funds primarily explain the Portuguese decrease in investments, since some funds were settling their investment periods, while others were incoming fundraising phases. Positively, there was a significant increase in exits, primarily to international strategic investors, which highlights Portugal's economic robustness and its stability in the global economy (EY, 2025).

2.4. Sources of Value Creation

Through providence in governance via advisory and monitoring, PE investors act as scrutinizers for these companies when regulators are insufficient, thus enhancing the value of the investee companies (Rawal & Kapil, 2023).

According to Rawal & Kapil (2023), value creation abilities are highlighted through PE's role, which is divided into three subthemes, namely fund performance, performance persistence, and value creation drivers.

In this context, Kaplan & Strömberg (2009) pointed out three main value drivers: (i) financial engineering, (ii) governance engineering, and (iii) operational engineering.

Kaplan & Strömberg (2009) defend the critical role of management incentives in PE portfolio companies, due to management's investment knowledge and abilities. Additionally, management's equity is illiquid, since the possibility to sell its equity or exercise its options is not given to management until an exit transaction proves this value. Consequently, management's motivation to diminish short-term performance is essentially reduced (Kaplan & Strömberg, 2009). Thus, monitoring and governance conducted by the PE fund can play an important role in the value-creation framework of PE firms (Gryglewicz & Mayer, 2023).

Since managers must make interest and principal payments, leverage pressures them to avoid wasting money. This can be associated with Agency Costs of Free Cash Flow (Jensen, 1986). This hypothesis, proposed by Jensen (1986), relies on the fact that when managers have a money surplus to fund positive NPV projects, they are incentivized to apply the excess money to less interesting investments, implying its waste. In this way, from the perspective of PE value creation, management teams in mature industries could dissipate cash flows. This prevents their return to investors, demonstrating the importance and relevance of financial engineering in mitigating this issue. Furthermore, leveraging the operations also presents the capacity to increase firm value through tax deductibility of interest (Kaplan & Strömberg, 2009). This motivates cash generation by managers to meet

not only principal repayment but also high interest, discouraging the misallocation of resources to unprofitable projects (Jensen, 1986).

PE investors' more active involvement in governance alongside their portfolio companies' board control enhances the governance engineering relevance in this context. More specifically, PE portfolio company boards frequently meet. Beyond that, investors in this sector do not hesitate to substitute any instances of suboptimal performing management, representing their focus and practicality, and, therefore, demonstrating the potential to create value for those companies (Kaplan & Strömberg, 2009).

Moreover, the application of industry and operational expertise to enhance the value of portfolio companies respects operational engineering. This leads PE firms to increasingly structure their organizations around industry specializations, hiring dealmakers possessing financial engineering capabilities complemented by operational experience and deep industry knowledge. Consequently, PE firms identify attractive investments through their industry and operating knowledge, resulting in the development of value creation plans and the implementation of those investments, underscoring the crucial role of operational engineering as a key driver of value creation (Kaplan & Strömberg, 2009).

Gompers et al. (2016) put forward a similar approach, in which there is a distinction between pre- and post-investment moments. Alongside their analysis, they also concluded that the value creation derives from a combination of financial, governance, and operational engineering. It is also worth mentioning Cohn et al. (2022)'s approach, which considered three sources of value creation, namely operational improvements, relaxation of financing constraints, and financial engineering. Moreover, Krysta & Kanbach (2022) differentiate the growth and efficiency value creation focus.

2.5. Empirical Evidence

2.5.1. Private Equity Impact on Its Portfolio Companies Through Time

Although there is a major consensus in the literature that PE firms can create value, a difference is noted in the academic research on this topic across the various waves of PE activity. Despite the worldwide diversification of the focus of the studies, firstly, PE studies were majorly focused on the US, whereas, from the second wave onwards, the studies also started being carried out relatively to the European buyout activity, with more emphasis on the UK (Mendes & Sousa, 2013).

Kaplan & Strömberg (2009) enhance firms' improvements as a result of their acquisition by PE companies. Firstly, it is denoted as an expressive operating and productivity improvement after leveraged buyouts alongside employment growth at these firms, even though presenting a lower rate when compared to a similar firm.

To understand the main value creation drivers in PE buyouts, Achleitner et al. (2010) examined 206 transactions, having focused their research on Continental Europe and the UK through an analysis of the period between 1991 and 2005. The findings of this empirical analysis indicate that two-thirds of PE returns are attributable to operational and market effects, whereas one-third can be ascribed to leverage. Complementarily, research carried out by Achleitner et al. (2011), analyzed 1,980 transactions in the period from 1986 to 2010, in which the main focus was Europe and North America, highlighted as fundamental explicator factors of equity returns not only leverage and operational improvements but also Earnings before Interest, Taxes, Depreciation and Amortization (EBITDA) multiple expansion.

To attest the difference between the performance of investments from PE firms and companies that do not receive an investment from those entities, Rossi & Martelanc (2013) conducted a study selecting companies that went public on the São Paulo Stock Exchange from 2004 to 2007, among which 30 had a PE firm as a shareholder before the Initial Public Offering (IPO), having analyzed the three prior and also post years of the IPO of each company. Through an analysis of different operational and financial indicators, such as Return-on-Equity (ROE) and Return-on-Assets (ROA), the authors found that PE-backed companies outperform firms that have not received an investment from those firms. Furthermore, it was also concluded that leverage and the ownership participation of funds present a positive and direct correlation, which reduces or even disappears after the IPO, which goes along with the already mentioned Kaplan & Strömberg (2009) approach regarding value creation drivers.

Contrarily, Vinten (2007), who supported his analysis on a sample of 73 Danish PE portfolio companies that were compared with 545 benchmark firms, from 1991 to 2004, and studied the operating performance, assets growth, capital structure, asset turnover and Return on Capital Employed (ROCE), found that PE portfolio firms' performance tends to fall. Consequently, this author found that PE fund ownership harms the performance of portfolio firms compared to similar ones.

Focusing on Portugal and in parallel with the last-mentioned research, Mendes & Sousa (2013) also concluded a negative impact of PE ownership. These authors analyzed a

sample of 101 buyouts that took place between 1996 and 2010. Through this research, they concluded a poor operating performance of portfolio companies after the buyout, since Return-on-Sales (ROS) (profitability) and ROA (productivity) declined, along with a decrease in EBITDA, despite the increase in both assets and sales.

Also studying the Portuguese PE market, Silva (2019) examined 121 PE buyouts along with a control group. It was found that turnover, total assets, and EBITDA of PE portfolio firms grew significantly higher than those of non-PE-backed companies. Nonetheless, it was concluded no evidence of improvement between the operating performance at the pre-entry and at post-entry periods, until the first three post-buyout years.

Comparing PE performance with the S&P 500, Higson & Stucke (2012) analyzed 1,169 US buyout funds between 1980 and 2008. The authors concluded that US buyout funds substantially outperformed public equity for almost every year, alongside the delivery of excess returns by liquidated funds. Nonetheless, it is important to emphasize that a notable decline trend in absolute returns across this period was also found.

This trend is also partially supported by Brown & Kaplan (2019), who calculated the Direct Alpha of US buyouts and compared it with the S&P 500 from 1986 until 2014. It was found that US buyout funds have surpassed public market indices, continuing their legacy and having demonstrated this trend even more recently.

Supplementarily, a study carried out by Gruener & Marburger (2022) also confirmed PE-backed companies' outperformance of public equity investments, extending their research not only to developed countries, as the majority of the literature has been focused, but to emerging markets. More specifically, this research was based on a sample of approximately 500 buyouts from different countries, among which Western, developed countries, and also emerging markets such as Brazil, India, and Peru, between 2007 and 2018. The authors found that PE presented a Compound Annual Growth (CAGR) of 13%, whereas the average annualized returns of S&P500 and MSCI World were 8% and 6%, respectively, supporting the PE outperformance of not only S&P500 but also MSCI World.

The literature reveals a detailed perspective on the value creation and performance impact of PE investments. There is a consensus regarding the potential of PE to enhance firms' productivity, profitability, and operational efficiency. However, while generally, PE-backed firms outperform non-PE-backed firms, counterexamples from countries like Portugal and Denmark show negative performance trends, challenging the universality of these benefits.

2.5.2. Private Equity Impact on Its Portfolio Companies During Crisis Periods

PE is said to be less exposed to economic cycles regarding its long-term investment horizons and has seemingly managed the recent crisis successfully (Arundale & Mason, 2020).

Large research conducted by Wilson et al. (2012), covering the period between 1995 and 2010, analyzed PE and non-PE-backed buyouts in the UK. Intending to analyze the GFC period, these authors concluded the value addition of PE firms to their portfolio companies. More specifically, greater economic and financial performance was achieved by PE-backed buyouts both before and during this global recession, outperforming non-PE-backed buyouts in productivity by 5-15% and also in profitability by 3-5%. Moreover, it was also noted that PE-backed companies presented positive revenue and employment growth.

Complementarily, Bernstein et al. (2020), who support their analysis on a sample of 1,984 firms in the UK, of which 722 are PE-backed companies, examined the period from 2004 to 2011. These authors noted that these companies decreased their investments significantly less than comparable firms, experiencing higher asset growth and having increased market share compared to non-PE-backed companies. Throughout the results, it can be highlighted that PE-backed firms faced this financial crisis better than non-PE-backed companies due to their active financial and operational resilience.

Nevertheless, regarding Portugal, Almeida (2018) analyzed 100 PE and VC transactions from 2007 until 2015, contrasting them with a control group to study the impact on the operating performance of national firms backed by PE after the GFC. Throughout this research, the author determined that the operating performance of PE/VC-backed companies was worse in comparison with the control group, since ROA (profitability) and ROS (productivity) of the treatment group decreased, contrasting with the control group.

Focusing on the last crisis period, the COVID-19 pandemic, apart from having represented a significant risk to PE portfolio companies, it also denoted an opportunity for PE firms to acquire quality companies at discounted prices, expanding their portfolios (Haarmeyer, 2020; Arundale & Mason, 2020), leading potentially to “huge benefits” for its investors (Malik et al., 2020).

Thus, Lavery & Wilson (2024) highlight the resilience of PE-backed companies when compared to closely matched non-PE-backed companies. The authors analyzed a sample focused on the UK, composed of 1,516 PE-backed firms and 2,825 control firms, centered on four different measures: sales, assets, employment, and earnings. It was determined an

outperformance, in all the dimensions, of PE-backed companies, even though the magnitude of this outperformance was lower than during the pre-pandemic period. However, these authors also found that these companies presented a higher probability of insolvency but demonstrated a higher likelihood of negotiation with creditors in order to continue trading instead of going into liquidation. In a nutshell, it was settled that the outperformance of PE-backed companies may be driven by the ex-ante selection of target firms, rather than just the support mechanisms that PE firms provide to their portfolio companies.

Comparing the impacts of the GFC and the COVID-19 pandemic, Lavery et al. (2024) focused their study on the UK, utilizing two matched samples—one for each crisis period—comprising 417 and 1,022 PE portfolio companies for each sample, respectively. This research is based on the contrast between the results of PE-backed companies and of matched companies that comprise the control group, examining the exporting resilience and working capital management of these companies. The conclusions emphasize the conceivable advantage of PE ownership in increasing resilience to the effects of these negative shocks in trade activities during crisis periods. This resilience was concluded to be more pronounced in GFC effects than in those following the COVID-19 pandemic. Finally, it is also pointed out that PE-backed firms have more efficient working capital management compared to their counterparts.

The literature shows that, although PE-backed companies decreased investments less than their peers (Bernstein et al., 2020), it is widely consensual that PE-backed companies outperform non-PE-backed companies, except for Portugal. Alongside this, these crisis periods can be taken as an opportunity by PE firms.

However, the COVID-19 crisis presented uniqueness (Fahlenbrach et al., 2021) in timing and severity terms (Lavery & Wilson, 2024), performing asymmetric effects (Papanikolaou & Schmidt, 2022) and so, contrarily, under the scope of the pandemic's impact on PE-backed companies, Gompers et al. (2022) concluded that investors presented pessimism regarding their expectation of declining revenues as a consequence of this shock.

3. Methodology and Sample Collection

Research on the impact of PE ownership during crisis periods remains relatively scarce and underexplored. More specifically, there is a lack of studies focused on the markets of small countries such as Portugal, and even more focusing on the latest crisis period, the COVID-19 pandemic.

As the main purpose of this study is to understand if the fact of being backed by PE helped in mitigating or, on the contrary, worsened the impact of the COVID-19 pandemic in those companies, the first research question will be the following:

Q1 Did the fact that companies were backed by PE help to minimize the impact of the COVID-19 pandemic on these firms' performance, or did it worsen it?

Furthermore, it is also important to understand if the fact of being backed by PE allowed a quicker recovery or, on the contrary, slowed down recovery post-COVID-19 pandemic in those companies. From here arises a second research question:

Q2 Did the fact that companies were backed by PE help them recover quicker from the post-COVID-19 pandemic impact, or slow down the recovery of the firms' performance?

Finally, in order to understand whether being backed by PE contributed to a stronger recovery when compared to pre-pandemic firm performance levels, or whether these companies struggled to return to their previous performance standards, the third research question is stated as follows:

Q3 Did the fact that companies were backed by PE lead to a better post-pandemic firm performance when compared to their pre-COVID-19 pandemic levels, or did it result in a weaker performance?

3.1. Methodology

To understand if the fact of being backed by PE helped in mitigating or, on the contrary, worsened the impact of the COVID-19 pandemic, a differences-in-differences (DiD) econometric model was applied.

This analysis, firstly, will be done over 4 years, which corresponds to 2018 to 2021. This interval was chosen considering the period from 2018 to 2019 as the pre-pandemic period and 2020 to 2021 as the pandemic period. It is important to highlight that 2020 was chosen as the first year of the pandemic period, considering that in Portugal, the first

lockdown was decreed on the 18th of March 2020 (Portuguese Republic Government, 2020).

Additionally, since the aim is also to understand if the fact of being backed by PE allowed a quicker recovery or, on the contrary, slowed down recovery post-COVID-19 pandemic in those companies, the period from 2020 to 2023 will also be analyzed under this context. In this case, the period from 2020 to 2021 is considered to be the pandemic period, whereas 2022 and 2023 are considered the post-COVID-19 pandemic years, representing the recovery period from this event. Specifically, it is important to note that only 2020 and 2021 are considered the pandemic years, considering that these are the moments in which this event had a strong impact, while in 2022, a greater tolerance was observed alongside a decrease in restrictions.

Finally, in order to conclude whether the fact of being backed by PE has a positive or negative impact while navigating COVID-19, the comparison between the companies' performance before (2018 to 2019) and after (2022 to 2023) pandemic periods will be analyzed.

To conduct these performance analyses, four different dimensions are considered: companies' sales, assets, employment, and earnings.

To ensure this analysis, it was followed an approach similar to Lavery & Wilson (2024), and so DiD technique and the model 3.1 were estimated.

$$y_{it} = \alpha_t + \alpha_i + \beta_1 PE_i * Post_t + \theta X_i * Post_t + \varepsilon_{it} \quad (3.1)$$

where y represents the outcome variable, specifically the variables i) sales, ii) assets, iii) employment (measured by the number of employees), and iv) earnings (measured by EBITDA). Then, PE is a dummy variable that takes a value of 1 for PE-backed companies and 0 for the control group. This first variable represents the same for the analysis of the three research questions. Subsequently, when answering the first research question (Q1), $Post_t$ is a dummy variable that assumes the value of 1 if the observation is from the pandemic period (2020 to 2021) and 0 if it is from the pre-pandemic period (2018 to 2019). On the analysis of the second research question (Q2), the variable $Post_t$ assumes the value of 1 when the observation is from the post-COVID-19 period (2022 and 2023), whereas it assumes the value of 0 when the observation is from the pandemic period (2020 to 2021). Additionally, for the third research question (Q3), the variable $Post_t$ assumes the value of 1 for observations from the post-pandemic years (2022 and 2023), and 0 for the observations from the pre-

pandemic years (2018 and 2019).

Firm-level control variables are represented by X_i and control for firms' characteristics during the pre-pandemic period, regarding Q1 and Q3, and during the pandemic period, regarding Q2. These variables are firm age, size (measured by total assets), cash holdings scaled by assets, sales growth, leverage (measured by total debt divided by total assets), and finally, profitability (measured by Earnings before Interest and Taxes (EBIT) divided by total assets)

Moreover, intending to formally explore, in more detail, how firm performance evolved over time around the pandemic, respecting Q1, over the post-COVID-19 pandemic period, regarding Q2 and Q3, a subsequent equation was estimated. To do so, the year-by-year effects of PE ownership around the pandemic and the post-pandemic period, were included following Lavery & Wilson (2024)'s methodology:

$$y_{it} = \alpha_t + \alpha_i + \beta_1 PE_i * Post_1 + \beta_2 PE_i * Post_2 + \theta_1 X_i * Post_1 + \theta_2 X_i * Post_2 + \varepsilon_{it} \quad (3.2)$$

where $Post_1$ and $Post_2$ represent the years 2020 and 2021 (for Q1), respectively, and 2022 and 2023 (for Q2 and Q3). correspondingly. It is relevant to mention that 2018 to 2019 is considered the basis period⁴ for the analyses of Q1 and Q3 since it is the period before the COVID-19 pandemic started, whereas 2020 to 2021 is taken as the reference period for the study of Q2 since it is the period before the beginning of the recovery from the pandemic.

3.2. Sample Selection

The sample selection process of this study consisted of two processes. First, information regarding the PE deals that occurred between 2010 and 2019 was retrieved from the *Orbis M&A* database to identify the respective Portuguese target companies. Second, the corresponding accounting information was retrieved from the *Sabi* database.

Similar to the strategy of Lavery & Wilson (2024), for a transaction to be included in this sample, three cumulative requirements needed to be satisfied: (i) only PE transactions; (ii) transactions completed between 2010 and 2019; (iii) transactions involving Portuguese target companies.

⁴ Lavery & Wilson (2024) use only the year before the impact as the reference year, instead of using the two-year period before the shock as the reference period, as it is applied in this present research.

The first requirement is essential because the main goal of this research is to analyze the effects of the COVID-19 pandemic on the performance of PE portfolio companies, as well as to assess their recovery compared to a control group.

The second criterion lies in the fact that the examination covers only the period of the COVID-19 pandemic and its subsequent period. Therefore, the companies under review must have been acquired by 2017 for Q1 and Q3, and by 2019 for Q2, ensuring that the analyzed PE portfolio companies have already been acquired at the beginning of the analysis period.

The third essential requirement of this research centers on the performance of Portuguese targets. Therefore, while the nationality of the PE firms does not matter, being allowed both Portuguese and foreign firms, the targets must be exclusively Portuguese.

Adjustments began by excluding targets without a BvD ID number, which is an identification number that can be used to collect both financial and accounting information from companies in *Orbis M&A* and *Sabi* databases. The lack of this identification number indicates that they are not regular companies. In some circumstances, they are a real estate portfolio. It is important to mention that without this identification number, companies' information needed to evaluate their performance cannot be collected. Next, PE portfolio companies sold before⁵ 2021 were omitted from the sample of Q1, as well as those that were sold before 2023, were excluded from the samples of Q2 and Q3. Companies facing dissolution, insolvency, or mergers were also removed. Moreover, companies with missing critical information were excluded as well. Furthermore, the US SIC codes were analyzed, and so, following a standard practice due to the intention of avoiding policies governed by regulation (Michaely & Roberts, 2012), companies presenting a primary US SIC code starting with 60 and 67 were discarded, as these codes respect financial services firms (Bernstein et al., 2019). Finally, targets that did not have non-PE portfolio companies presenting accounting information compatible with the criteria of the control group were also rejected.

Consequently, on the one hand, the sample of Q1 presented a reduction from 93 to 35 deals. On the other hand, it is observed that the sample of Q2 reduced from 138 to 43 target companies. A summary of the samples differentiated by the two research questions can be observed in Panels A and B of Table 1.

⁵ Even when it only occurred a partial exit, the respective company was also excluded.

Table 1 - Sample selection summary

	Number of Transactions
<u>Panel A: sample of the first research question</u>	
Initial Sample	
Criteria:	
Type: Private Equity	
Time Period: 2010-2017	93
Target Company: Headquartered in Portugal	
Exclusions:	
Targets that do not present BvD ID number	3
Targets sold before 2021	22
Targets facing dissolution, insolvency, or mergers during the analysis period	21
Missing accounting information	2
Companies with US SIC codes 60/67	5
Targets without Control Group	5
Final Sample	35
<u>Panel B: sample of the second research question</u>	
Initial Sample	
Criteria:	
Type: Private Equity	
Time Period: 2010-2019	138
Target Company: Headquartered in Portugal	
Exclusions:	
Targets that do not present BvD ID number	9
Targets sold before 2023	32
Targets facing dissolution, insolvency, or mergers during the analysis period	21
Missing accounting information	11
Companies with US SIC codes 60/67	8
Targets without Control Group	14
Final Sample	43

Focusing on Q3, since its purpose lies in the study of the recovery comparison between PE- and non-PE-backed companies from the pre- to the post-pandemic period, its sample is constituted by the buyouts that occurred in Portugal until 2017, respecting all the criteria. Alongside that, the target companies must not have exited by 2023. Consequently, the firms that compose this sample are the common targets between the samples of Q1 and Q2, resulting in a sample composition of 22 PE portfolio firms.

3.3. Control Sample

As mentioned, a control sample was created, intending to match each PE-backed company presented in the sample to similar companies that did not have the investment by a PE firm.

The criteria for creating the control sample were based on the approach by Lavery & Wilson (2024), focusing on matching PE-owned firms across industry, size, leverage, and assets' profitability. As a result, to match PE portfolio companies with the control firm, the following principles were applied: (i) control firms should have the same two-digit US SIC code as the treated PE-backed firm; (ii) the total assets in the basis year (2019 for the samples concerning Q1 and Q3, and 2021 regarding the sample of Q2) of control group companies should be within a 30% bandwidth as the treated firm; (iii) the selected control group firm should have leverage (measure by total debt divided by total assets) within a 15-percentage points bandwidth in the basis year; (iv) control group firms should present ROA (measured by EBIT divided by total assets) within a 30% bandwidth in the basis year. It is crucial to mention that when these criteria did not produce results, the ROA criterion was adjusted, having been expanded to a bandwidth of 3 percentage points. However, as already mentioned, there were target companies that did not have suitable control companies and, consequently, were excluded from the sample. Moreover, the comparable sample was stressed against another criterion, implying that the comparable sample companies were not the target of a PE deal during the analysis period.

Finally, it is important to note that each PE-backed firm is matched up to five control firms. In case the target firm matches more than five control firms based on these matching criteria, the five chosen control companies were the ones that presented the closest leverage to that of the target company. This selection focused on the leverage criterion since it is the broadest, unless cases required adjusting the ROA criterion. In those instances, the company with the closest ROA in the base year was selected, resulting in these target companies having only one comparable company.

The final sample is composed of 261 comparable companies, of which 87 correspond to the first research question, 112 respect the second research question, and 62 regard the third research question, controlling for industry, size, leverage, and assets' profitability.

3.4.Descriptive Statistics

In order to gain a comprehensive understanding of the group of PE portfolio companies, the control group, and the groups representing pre-pandemic, pandemic, and post-pandemic periods, a statistical analysis was conducted on the pertinent variables relevant to this dissertation.

3.4.1. Pandemic Impact on PE Portfolio Companies' Performance

First, focusing on the analysis of Q1, Table 2 presents the summary statistics of the PE-backed firms' group and their matched companies' group for the pre-pandemic year (2019). Furthermore, Panels A and B show the characteristics of the variables and the ratios, respectively.

Analyzing Table 2, the descriptive statistics show that there can be examined differences between the mean and median values of PE-backed companies and control firms. However, in general, these differences are not statistically significant, with only a few exceptional instances demonstrating statistical significance, which present a minimal difference. This means that, overall, the matching algorithm seems to function effectively.

Finally, as exhibited in Panel B of Table 2, ROA of PE portfolio companies is slightly lower than that of control firms. Since the Debt/EBITDA of PE portfolio companies is statistically significantly higher than that of non-PE-backed firms, those PE portfolio companies tend to be more leveraged.

Table 3 demonstrates the descriptive statistics of the pre-pandemic and pandemic groups of all the companies under analysis. It is observable that Total Cash and Cash/Assets increased during the pandemic period, while ROA slightly decreased from the pre- to the pandemic period.

Table 2 - Characteristics of PE and control samples in 2019 (sample of the first research question)

Table 2 reports summary statistics for the pre-pandemic year (2019) of PE and control samples, as well as the difference between the mean and median values of the two samples. PE refers to all the PE-backed companies, whereas Control refers to a sample of non-PE-backed companies, matched on their first two-digit US SIC codes, total assets, ROA (EBIT/total assets), and leverage (total debt/total assets) within a 30% bracket (regarding total assets and ROA) and 15 percentage point bandwidth (respecting leverage) in the pre-pandemic year, considering that exceptionally, when these criteria did not produce results, the ROA criterion was adjusted to a bandwidth of 3 percentage points. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the PE sample are significantly different from the Control sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	PE						Control						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	35	34	34	22	3	194	87	28	28	25	3	108	6	-3
Employment (n)	35	125	125	94	0	404	87	214	192	60	0	4,954	-67	34
Total Assets (€000)	35	27,500	27,500	13,700	1,619	120,000	87	21,600	21,300	11,700	1,257	143,000	6,200	2,000
Total Debt (€000)	35	11,100	11,000	3,662	0	64,800	87	7,437	7,437	3,291	0	58,600	3,563	371
Total Cash (€000)	35	834	834	326	1	3,892	87	1,145	1,138	255	6	12,100	-304	70
Sales (€000)	35	25,600	24,600	9,214	0	216,000	87	18,000	18,000	7,929	272	154,000	6,600	1,285
EBITDA (€000)	35	2,192	2,230	769	-1,977	11,100	87	1,904	1,871	674	-642	15,100	359	95
Panel B														
Return On Assets	35	0.02	0.02	0.03	-0.21	0.21	87	0.04	0.04	0.05	-0.21	0.15	-0.02	-0.02*
Leverage	35	0.36	0.36	0.36	0.00	0.79	87	0.33	0.33	0.33	0.00	0.95	0.04	0.03
EBITDA Margin	34	0.12	0.12	0.08	-0.26	0.52	87	0.11	0.13	0.10	-1.84	0.77	-0.01	-0.03
Cash/Assets	35	0.05	0.05	0.02	0.00	0.46	87	0.08	0.08	0.02	0.00	0.63	-0.03	0.00
Debt/EBITDA	35	9.03	9.03	4.56	-23.39	74.31	87	146.70	5.86	3.41	-79.47	12,450.13	3.17	1.15*

(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are PE values less Control values.

Table 3 - Characteristics of pre-pandemic and during pandemic samples (sample of the first research question)

Table 3 reports summary statistics of pre-pandemic and during pandemic samples, including all the companies of both target and control groups, as well as the difference between the mean and median values of the two samples. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the pre-pandemic sample are significantly different from the during pandemic sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	Pre-Pandemic						During Pandemic						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	243	29	29	24	2	194	244	31	31	26	4	196	2	2
Employment (n)	243	185	167	62	0	5,398	244	190	180	68	0	4,878	13	6
Total Assets (€000)	243	22,700	22,600	12,000	748	143,000	244	25,100	24,700	13,300	1,221	215,000	2,100	1,300
Total Debt (€000)	243	8,181	8,125	3,230	0	72,000	244	8,976	8,892	4,137	0	82,700	766	907
Total Cash (€000)	243	8,181	974	252	1	12,700	244	1,469	1,452	486	1	16,000	478**	234***
Sales (€000)	243	19,700	19,300	7,929	0	234,000	244	20,400	20,200	8,274	0	219,000	900	345
EBITDA (€000)	243	2,040	1,988	669	-4	32,200	244	2,171	2,096	780	-3,794	30,100	108	111
Panel B														
Return On Assets	243	0.05	0.04	0.05	-0.21	0.66	244	0.03	0.03	0.03	-0.22	0.28	-0.01	-0.02**
Leverage	243	0.33	0.33	0.34	0.00	0.95	244	0.35	0.35	0.35	0.00	1.14	0.02	0.01
EBITDA Margin	239	0.13	0.12	0.10	-1.84	3.15	242	0.12	0.10	0.10	-1.11	2.83	-0.02	0.00
Cash/Assets	243	0.07	0.07	0.02	0.00	0.66	244	0.09	0.09	0.04	0.00	0.68	0.02**	0.02***
Debt/EBITDA	243	55.06	5.03	3.32	-178.53	12,450.13	244	5.20	4.15	3.30	-174.72	453.37	-0.89	-0.01

(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are During Pandemic values less Pre-Pandemic values.

To provide support for the parallel trends' assumption, the analysis is extended to examine the dynamics of firm performance over time in the context of the pandemic. To formally investigate the evolution in greater detail, the following equation was estimated, which captures the year-by-year effects of PE ownership surrounding the shock period:

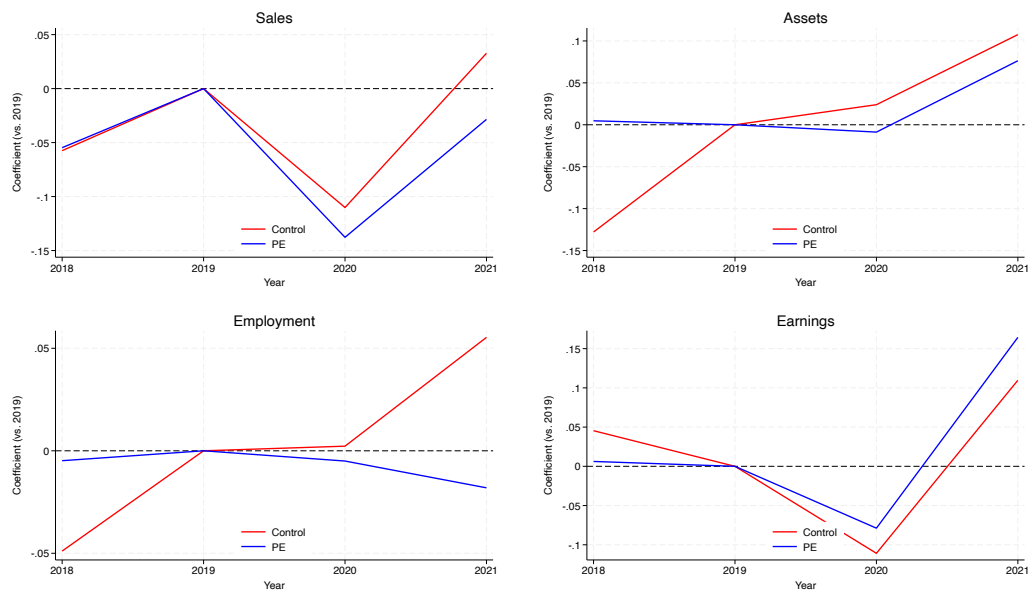
$$\log(y_{it}) = \alpha_t + \alpha_i + \varepsilon_{it} \quad (3.3)$$

In this specification, 2019 (for Q1 and Q3) and 2021 (for Q2) were considered the basis year, having their coefficients normalized to zero. Based on the matching methodology (described in Section 3.3), any potential impact of the PE ownership on the firm performance is expected to emerge, if at all, only with the onset of the pandemic.

Examining the evolution of the different dependent variables presented in Figure 3, it can be observed that the trends of the target and control groups do not diverge before the pandemic began, except for Assets, whose behavior of PE and non-PE portfolio companies slightly diverges before the onset of the pandemic.

Figure 3 - Effect of PE ownership on firm performance during the COVID-19 pandemic (sample of the first research question)

Figure 3 presents the effect of PE ownership on firm performance during the COVID-19 pandemic, focusing on the four dependent variables of this study (Sales, Assets, Employment, and Earnings). This figure reports the α_t of Equation (3.3) where α_t captures the year fixed effects and α_i captures the firm fixed effects. The year before the pandemic, 2019, is the basis period, and its corresponding coefficient is normalized to zero. The equation is estimated separately for both the PE-backed and control firms, with standard errors clustered at the company level. All the variables are winsorized at the 1% level.



3.4.2. Performance Recovery of PE Portfolio Companies from the Pandemic

Second, centering on the analysis of Q2, Table 4 presents the summary statistics of the PE-backed firms' group and the matched companies' group for the pre-recovery year (2021). Specifically, Panels A and B show the characteristics of the variables and the ratios, respectively. Analyzing Table 4, it can be concluded that the differences between the medians and means are, generally, not statistically significant (being the main difference the higher leverage of PE-backed companies), suggesting that the matching process has worked well.

Additionally, according to Panel B of Table 4, PE-backed companies present a minimally lower ROA and a higher leverage than non-PE portfolio companies.

Table 4 - Characteristics of PE and control samples in 2021 (sample of the second research question)

Table 4 reports summary statistics for the pre-post-pandemic year (2021) of PE and control samples, as well as the difference between the mean and median values of the two samples. PE refers to all the PE-backed companies, whereas Control refers to a sample of non-PE-backed companies, matched on their first two-digit US SIC codes, total assets, ROA (EBIT/total assets), and leverage (total debt/total assets) within a 30% bracket (regarding total assets and ROA) and 15 percentage point bandwidth (respecting leverage) in the pre-post-pandemic year, considering that exceptionally, when these criteria did not produce results, the ROA criterion was adjusted to a bandwidth of 3 percentage points. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the PE sample are significantly different from the Control sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	PE						Control						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	43	29	29	23	8	103	112	26	26	24	3	75	2	-1
Employment (n)	43	98	98	76	0	397	112	126	126	48	0	1,653	-27	28
Total Assets (€000)	43	67,000	66,800	16,100	973	780,000	112	33,500	33,500	11,900	822	768,000	33,300*	4,200**
Total Debt (€000)	43	36,600	36,600	4,778	0	557,000	112	16,600	16,200	1,384	0	601,000	20,400	3,393***
Total Cash (€000)	43	3,325	3,316	826	0	36,600	112	1,969	1,969	702	0	14,100	1,347	123
Sales (€000)	43	21,800	21,600	9,785	1,084	176,000	112	15,600	15,600	9,460	0	145,000	6,000	325
EBITDA (€000)	43	3,792	3,845	1,651	-3,898	55,000	112	3,047	3,000	1,181	-1,607	65,400	845	470
Panel B														
Return On Assets	43	0.05	0.05	0.04	-0.17	0.28	112	0.07	0.07	0.06	-0.13	0.29	-0.02	-0.02*
Leverage	43	0.35	0.35	0.34	0.00	1.33	112	0.26	0.26	0.18	0.00	1.28	0.10**	0.16**
EBITDA Margin	43	0.18	0.18	0.11	-2.34	2.41	111	0.19	0.17	0.15	-3.27	5.47	0.01	-0.04
Cash/Assets	43	0.11	0.11	0.06	0.00	0.68	112	0.14	0.14	0.09	0.00	0.63	-0.03	-0.03
Debt/EBITDA	43	1.71	6.60	2.85	-290.62	99.92	112	10.77	7.93	1.35	-54.45	568.22	-1.33	1.50

(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are PE values less Control values.

Table 5 demonstrates the descriptive statistics of the pandemic and post-pandemic groups, considering that Panels A and B show the characteristics of the variables and the ratios, respectively.

The results suggest that during the post-pandemic period, both PE-backed companies and non-PE firms generated higher revenues compared to the pandemic period. Alongside, these companies also reported higher operational earnings during the post-pandemic years, when contrasted with the pandemic period.

Interpreting the results of Panel B of Table 5, it is understandable that ROA slightly increased from the pandemic to the post-pandemic period, whereas all the companies under analysis viewed their leverage decrease subtly.

Table 5 - Characteristics of during pandemic and post-pandemic samples (sample of the second research question)

Table 5 reports summary statistics of during pandemic and post-pandemic samples, including all the companies of both target and control groups, as well as the difference between the mean and median values of the two samples. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the during pandemic sample are significantly different from the post-pandemic sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	During Pandemic						Post-Pandemic						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	310	26	26	23	2	103	310	28	28	25	4	105	2*	2*
Employment (n)	310	116	115	52	0	1,653	310	123	121	54	0	2,014	5	2
Total Assets (€000)	310	42,600	40,400	12,400	581	898,000	310	42,500	42,100	14,200	0	707,000	1,700	1,800
Total Debt (€000)	310	22,900	21,100	2,061	0	648,000	310	20,500	20,100	1,693	0	555,000	-1,000	-368
Total Cash (€000)	310	2,289	2,169	717	0	73,100	310	2,493	2,366	756	0	56,700	197	39
Sales (€000)	310	16,700	16,600	9,286	0	219,000	310	21,400	21,000	11,300	0	254,000	4,400**	2,014***
EBITDA (€000)	310	3,241	3,213	1,097	-4,871	65,400	310	4,042	4,001	1,616	-6,173,711	75,600	788	519***
Panel B														
Return On Assets	310	0.06	0.06	0.05	-0.34	0.38	309	0.08	0.08	0.07	-0.29	0.67	0.02***	0.02***
Leverage	310	0.29	0.29	0.27	0.00	1.33	308	0.25	0.25	0.20	0.00	1.30	-0.04	-0.06**
EBITDA Margin	308	-0.51	0.19	0.14	-218.27	5.47	308	0.23	0.21	0.14	-0.62	4.53	0.03	0.01
Cash/Assets	310	0.14	0.14	0.08	0.00	0.72	309	0.12	0.12	0.06	0.00	0.64	-0.01	-0.02
Debt/EBITDA	310	-12.32	3.50	1.70	-5,514.49	568.22	309	2.42	3.26	1.13	-269.63	202.72	-0.24	-0.57

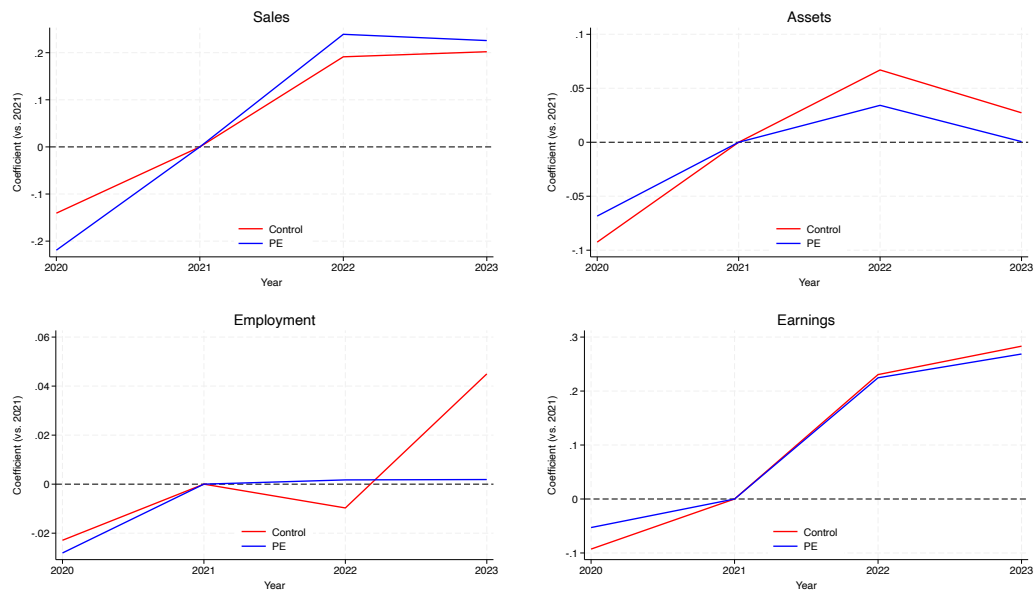
(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are Post-Pandemic values less During Pandemic values.

Equation (3.3) was also estimated for the sample related to the second research question. Examining the evolution of the various dependent variables, in Figure 4, it can be observed that the performances of the treatment and control groups do not diverge during the pandemic period. This reinforces the validity of the matching procedure, indicating that it successfully balanced the treatment and control groups during the pandemic.

Figure 4 - Effect of PE ownership on firm performance during the post-COVID-19 pandemic (sample of the second research question)

Figure 4 presents the effect of PE ownership on firm performance during the post-COVID-19 pandemic, focusing on the four dependent variables of this study (Sales, Assets, Employment, and Earnings). This figure reports the α_t of Equation (3.3), where α_t captures the year fixed effects and α_i captures the firm fixed effects. The year before the post-pandemic, 2021, is the basis period, and its corresponding coefficient is normalized to zero. The equation is estimated separately for both the PE-backed and control firms, with standard errors clustered at the company level. All the variables are winsorized at the 1% level.



3.4.3. Pre- and Post-Pandemic Performance Comparison of PE Portfolio Companies

Third, focusing on the analysis of Q3, Table 6 presents the summary statistics of the PE-backed firms' group and their matched companies' group for the pre-pandemic year (2019). Moreover, Panels A and B show the characteristics of the variables and the ratios, respectively.

When examining Table 6, there are observed differences between the groups of PE-backed companies and their matched counterparts. Taken together, the matching algorithm appears to work effectively, as the disparities between the mean and median values of PE-backed companies and control firms are generally slight.

Additionally, these differences are predominantly not statistically significant, with only a few notable cases showing statistical significance, indicating minimal variation. More specifically, Panel B of Table 6 indicates that ROA and Cash/Assets of PE-backed firms are lower than those of their matched counterparts.

Table 7 reports the descriptive statistics of the pre- and post-pandemic groups. It can be observed in Panel A of Table 7 that from the pre- to the post-pandemic period, both PE and non-PE-backed companies experienced an increase in Total Assets, Sales, and EBITDA. This may reflect the dynamics of post-crisis recovery and can be attributed to the overall economic rebound following the COVID-19 crisis. An increase in Total Cash holdings from the pre- to the post-pandemic period may reflect precautionary liquidity management strategies among economic uncertainty.

Lastly, in Panel B of Table 7, a slight rise in Cash/Assets is observed from the pre- to the post-pandemic period, which may reflect cautious financial behavior in response to increased uncertainty, as firms may have opted to retain higher proportions of liquid assets relative to their total balance sheet.

Table 6 - Characteristics of PE and control samples in 2019 (sample of the third research question)

Table 6 reports summary statistics for the pre-pandemic year (2019) of PE and control samples, as well as the difference between the mean and median values of the two samples. PE refers to all the PE-backed companies, whereas Control refers to a sample of non-PE-backed companies, matched on their first two-digit US SIC codes, total assets, ROA (EBIT/total assets), and leverage (total debt/total assets) within a 30% bracket (regarding total assets and ROA) and 15 percentage point bandwidth (respecting leverage) in the pre-pandemic year, considering that exceptionally, when these criteria did not produce results, the ROA criterion was adjusted to a bandwidth of 3 percentage points. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the PE sample are significantly different from the Control sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	PE						Control						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	22	29	29	22	6	101	62	27	27	25	3	108	1	-3
Employment (n)	22	104	104	75	9	404	62	192	192	48	0	4,954	-88	27
Total Assets (€000)	22	24,100	24,100	11,800	1,619	120,000	62	19,000	19,000	9,650	1,257	143,000	5,100	2,150
Total Debt (€000)	22	8,622	8,622	3,590	0	59,600	62	6,661	6,661	3,014	0	58,600	1,962	576
Total Cash (€000)	22	624	624	254	1	3,892	62	972	972	326	8	12,100	-347	-71
Sales (€000)	22	30,200	30,200	9,074	1,498	216,000	62	17,400	17,400	5,868	272	154,000	12,800	3,205
EBITDA (€000)	22	2,036	2,036	649	-474	9,953	62	1,746	1,746	620	-523	15,100	290	29
Panel B														
Return On Assets	22	0.02	0.02	0.03	-0.21	0.11	62	0.11	0.11	0.09	-0.05	0.46	-0.09***	-0.06***
Leverage	22	0.32	0.32	0.34	0.00	0.54	62	1.01	1.01	0.37	0.00	16.69	-0.69	-0.03
EBITDA Margin	22	0.09	0.09	0.07	-0.26	0.35	62	0.10	0.10	0.10	-1.84	0.77	-0.01	-0.03
Cash/Assets	22	0.06	0.06	0.02	0.00	0.46	62	0.11	0.11	0.06	0.00	0.68	-0.05	-0.04**
Debt/EBITDA	22	8.18	8.18	4.43	-23.39	74.31	62	7.69	7.69	5.24	-111.91	170.24	0.49	-0.81

(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are PE values less Control values.

Table 7 - Characteristics of pre-pandemic and post-pandemic samples (sample of the third research question)

Table 7 reports summary statistics of pre-pandemic and post-pandemic samples, including all the companies of both target and control groups, as well as the difference between the mean and median values of the two samples. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the pre-pandemic sample are significantly different from the post-pandemic sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	Pre-Pandemic						Post-Pandemic						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	168	27	27	24	2	108	165	31	31	27	6	112	4**	4**
Employment (n)	168	167	155	49	0	5,389	165	177	176	55	0	4,192	22	6
Total Assets (€000)	168	19,800	19,800	10,000	748	143,000	165	24,900	24,700	11,700	1,143	168,000	4,900*	1,700*
Total Debt (€000)	168	7,019	7,019	3,068	0	62,900	168	7,740	7,645	2,600	0	69,000	626	-468
Total Cash (€000)	168	812	763	262	1	12,700	165	953	953	425	4	8,395	189	163*
Sales (€000)	168	20,500	20,400	6,322	0	234,000	165	27,500	27,200	8,919	219	254,000	6,800*	2,597*
EBITDA (€000)	168	1,949	1,892	582	-2,835	32,200	165	2,700	2,576	787	-385,971	38,600	685**	205*
Panel B														
Return On Assets	168	0.09	0.09	0.08	-0.25	0.56	168	0.10	0.10	0.08	-0.25	0.67	0.00	0.00
Leverage	168	0.85	0.82	0.35	0.00	16.69	168	0.92	0.82	0.32	0.00	21.39	-0.01	-0.03
EBITDA Margin	167	0.13	0.12	0.10	-1.84	3.15	165	0.14	0.14	0.10	-0.46	2.06	0.01	0.00
Cash/Assets	168	0.09	0.09	0.04	0.00	0.68	168	0.12	0.12	0.05	0.00	0.64	0.03**	0.02*
Debt/EBITDA	168	6.39	7.18	4.70	-176.49	276.90	165	7.34	5.41	3.61	-42.10	466.38	-1.77	-1.10

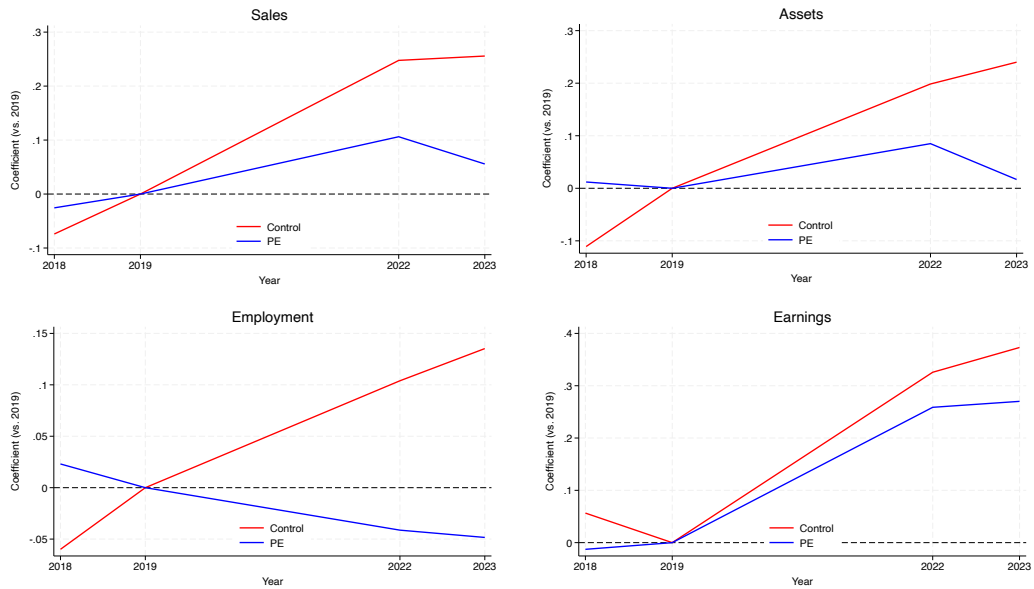
(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are Post-Pandemic values less Pre-Pandemic values.

Equation (3.3) was also estimated using the sample related to the third research question. As illustrated in Figure 5, the evolution of the different dependent variables reveals that, even though not particularly pronounced, there is divergence in performance between the treatment and control groups during the pre-pandemic period. These divergences occur for Assets, Employment, and Earnings behavior. Although this means that the results must be taken with some caution, robustness checks later in the study will minimize this impact.

Figure 5 - Effect of PE ownership on firm performance during the post-COVID-19 pandemic (sample of the third research question)

Figure 5 presents the effect of PE ownership on firm performance during the post-COVID-19 pandemic, focusing on the four dependent variables of this study (Sales, Assets, Employment, and Earnings). This figure reports the α_t of Equation (3.3), where α_t captures the year fixed effects and α_i captures the firm fixed effects. The year before the pandemic, 2019, is the basis period, and its corresponding coefficient is normalized to zero. The equation is estimated separately for both the PE-backed and control firms, with standard errors clustered at the company level. All the variables are winsorized at the 1% level.



4. Results

4.1. Pandemic Impact on PE Portfolio Companies' Performance

This section aims to focus on the first research question, i.e., whether the impact of the COVID-19 pandemic on the performance of companies was minimized (or worsened) by the presence of PE firms in the ownership structure.

Panel A of Table 8 presents the baseline findings from estimating Equation (3.1), demonstrating whether PE-backed firms outperformed their matched control counterparts during the COVID-19 pandemic. Each specification includes both firm and year fixed effects. While the estimates presented in Panel A of Table 8 indicate the average variation in firm performance from the period preceding the pandemic (2018 and 2019) to the pandemic period (2020 and 2021), they fail to provide insights regarding the timing of these variations. Consequently, Panel B of Table 8 illustrates the findings derived from Equation (3.2), which reveals the time-varying behavior of the treatment effects of the dependent variables compared to the period before the beginning of the pandemic (2018 to 2019).

Table 8 - Firm performance during the pandemic

Panel A of Table 8 presents the results from the baseline DiD model, Equation (3.1). PE_i is a dummy variable that equals one for PE-backed companies and zero for the control group. $Post_i$ is a dummy variable that equals one for observations during the period of 2020 and 2021, and zero in the pre-pandemic years, 2018 and 2019. Panel B shows the estimates from Equation (3.2), using the pre-pandemic period, 2018 to 2019, as the reference period. All the variables (except for firm age) are winsorized at the 1% level. The Newey-West estimator was applied, and the standard errors are presented in parentheses. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

	Sales	Assets	Employment	Earnings
Panel A: Baseline differences-in-differences				
PE*Post	-2,001,250 (1,424,012)	-2,637,656** (1,213,115)	-17.47** (8.14)	116,571 (345,393.80)
Panel B: Year-by-year effects				
PE*2020	-2,619,031** (1,292,294)	-2,374,538* (1,245,397)	-10.23* (5.81)	-195,812 (334,428.60)
PE*2021	-1,322,893 (1,815,969)	-2,790,309** (1,353,766)	-24.69** (11.28)	483,509 (406,950.40)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	478	478	478	478

According to Panel A of Table 8, there is no statistical significance for both sales and earnings behavior during the pandemic period compared to the control firms. However, the assets of PE portfolio companies increased, on average, by €2.6 million less (at a 5% significance level) compared to those of non-PE-backed firms, during the pandemic period. Additionally, PE companies decreased, on average, 17 more employees than non-PE-backed companies (at a 5% confidence level) during the pandemic.

Furthermore, Panel B of Table 8 shows that the underperformance in terms of sales by PE-backed companies occurred mainly in the first year of the pandemic (2020). While in terms of assets and employment, the impact is still significantly negative in 2021.

Focusing on employment, target companies presented approximately 10 fewer employees in 2020 than in the pre-pandemic period (at a 10% significance level), in comparison to the same difference regarding control companies. While in 2021 the number of employees reduced even more, when compared with the same of non-PE-backed companies, achieving an additional reduction of 25 employees when compared with the pre-pandemic period (at a 5% significance level).

In conclusion, focusing on Q1 and so, analyzing the pre-pandemic and pandemic periods, it can be concluded that sales (although they recovered, at least partially, in 2021), assets, and the number of employees of PE-backed companies were more negatively impacted than those of control companies.

4.2. Performance Recovery of PE Portfolio Companies from the Pandemic

This section aims to determine whether being backed by PE facilitated a quicker recovery from the post-COVID-19 pandemic impact or slowed down the recovery of these firms compared to non-PE-backed companies, focusing on the second research question.

Panel A of Table 9 provides the baseline findings derived from estimating Equation (3.1), investigating whether PE-backed firms have outperformed their matched control counterparts in the aftermath of the COVID-19 pandemic. Each specification encompasses both firm-specific and year-specific fixed effects. The estimates presented in Panel A of Table 9 illustrate the average variation in firm performance transitioning from the pandemic period (2020 and 2021) to the subsequent period (2022 and 2023). However, they do not delineate the timing of these variations. Thus, Panel B of Table 9 presents findings from

Equation (3.2), showcasing the time-varying behavior of treatment effects of the dependent variables concerning the pandemic period (2020 and 2021).

Table 9 - Firm performance during the post-pandemic

Panel A of Table 9 presents the results from the baseline DiD model, Equation (3.1). PE_i is a dummy variable that equals one for PE-backed companies and zero for the control group. $Post_i$ is a dummy variable that equals one for observations during the period of 2022 and 2023, and zero in the pandemic years, 2020 and 2021. Panel B shows the estimates from Equation (3.2), using the pandemic period, 2020 and 2021, as the reference period. All the variables (except for firm age) are winsorized at the 1% level. The Newey-West estimator was applied, and the standard errors are presented in parentheses. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

	Sales	Assets	Employment	Earnings
Panel A: Baseline differences-in-differences				
PE*Post	2,143,140 (2,669,199)	-5,196,477** (2,441,405)	-0.66 (5.40)	-191,711.50 (488,709.80)
Panel B: Year-by-year effects				
PE*2022	2,384,501 (2,936,873)	-4,009,769** (1,975,737)	4.49 (9.00)	48,108.53 (473,822.20)
PE*2023	1,887,714 (2,418,657)	-6,426,951** (3,082,606)	-5.20 (8.67)	-517,103.60 (571,203.70)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	613	613	613	613

According to Panel A of Table 9, even though there is no statistical significance of sales, employment and earnings behavior during the post-COVID-19 pandemic period, assets of companies acquired by PE firms by 2019, and that remained in their portfolio by 2023, increased less €5.2 million (at a 5% significance level) than those of the control companies.

Concerning the year-by-year effects, as shown in Panel B of Table 9, from the pandemic period to 2022 and 2023, the assets of PE portfolio companies increased statistically significantly less than those of control companies, when compared with the pandemic period (2020 and 2021)

This analysis indicates that, focusing on Q2, the PE-backed companies recovered more slowly in terms of total assets and were not statistically different in terms of sales, employees, and earnings than non-PE-backed companies, from the pandemic to the post-pandemic period.

4.3. Pre- and Post-Pandemic Performance Comparison of PE Portfolio Companies

This section concentrates on the third research question, investigating whether PE-backed companies were able to restore their firm performance to pre-pandemic levels or whether their recovery was comparatively weaker, contrasted with non-PE-backed companies.

Panel A of Table 10 presents the baseline results obtained from estimating Equation (3.1), which compares the performance of PE-backed firms with that of their matched non-PE counterparts between the pre-pandemic period (2018 and 2019) and the post-pandemic period (2022 and 2023). All model specifications include firm and year fixed effects. While these estimates provide insights into the average variation in firm performance between the two periods, they do not capture the timing or progression of the recovery relative to pre-pandemic benchmarks. To address this limitation, Panel B of Table 10 reports the results from Equation (3.2), which allows for a time-varying analysis of the treatment effects by comparing each recovery year to the pre-pandemic period.

Table 10 - Firm performance during the post-pandemic

Panel A of Table 10 presents the results from the baseline DiD model, Equation (3.1). PE_i is a dummy variable that equals one for PE-backed companies and zero for the control group. $Post_t$ is a dummy variable that equals one for observations during the period of 2022 and 2023, and zero in the pre-pandemic years, 2018 and 2019. Panel B shows the estimates from Equation (3.2), using the pre-pandemic period, 2018 to 2019, as the reference period. All the variables (except for firm age) are winsorized at the 1% level. The Newey-West estimator was applied, and the standard errors are presented in parentheses. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

	Sales	Assets	Employment	Earnings
Panel A: Baseline differences-in-differences				
PE*Post	-511,160.50 (5,324,856)	-2,849,193* (1,619,631)	-30.12*** (9.70)	-86,741.46 (318,166.70)
Panel B: Year-by-year effects				
PE*2022	343,817 (6,657,248)	-2,267,667 (1,598,791)	-34.16** (14.97)	-250,919.40 (339,029.70)
PE*2023	-1,328,689 (4,637,374)	-3,562,518** (1,755,980)	-25.26** (9.85)	79,103.35 (444,160.80)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	331	331	331	331

Given the results of Panel A of Table 10, it is concluded that the assets of target companies increased by €2.8 million less (at a 10% significance level) than those of the control group during the post-pandemic period. Additionally, PE portfolio companies presented approximately a 30 drop in the number of employees (at a 1% confidence level) during the post-pandemic period in comparison to non-PE portfolio companies.

Moreover, Panel B of Table 10 reveals that from the pre-pandemic period to 2023, the assets of PE portfolio companies increased statistically significantly less than those of control companies. This tendency was also observed in employment, since from the pre-pandemic period to 2022 and to 2023, the number of employees of target companies was statistically significantly more negatively impacted than that of matched firms.

To sum up, regarding Q3, both PE portfolio companies' assets and the number of employees presented a slower recovery from pre- to post-pandemic periods compared to non-PE-backed firms. Conversely, this recovery of both PE and non-PE portfolio companies was not statistically significantly different regarding sales and earnings dimensions.

4.4. Robustness Check

To ensure the validity of the baseline results, robustness checks were performed using Propensity Score Matching (PSM) to create the matchings between the target companies and the control firms of Q1, Q2, and Q3's samples to have causal inferences improved (Li & Xue, 2024), not imposing linearity (Sincerre et al., 2018).

Consequently, the control sample that derived from the procedure mentioned in Section 3.3 remained, considering that for robustness check effects, the matching procedure respected the PSM.

Specifically, a 1-to-1 nearest-neighbor matching method was implemented based on the PSM to achieve more reliable matches. In addition, caliper matching was applied, which is represented by a minimum tolerance (0.01 in the case of this study). This effectively establishes a maximum tolerance level for the propensity score distance, helping to prevent poor matches (Stiebale & Wößner, 2020). Moreover, this matching procedure was conducted with replacement and imposing a common support condition.

Furthermore, the variables used in this logit model remained the same as those that were used to create the control samples of all the research questions (Section 3.3), naming

the two-digit US SIC code of the treated PE-backed firm, total assets, leverage (measured by total debt divided by total assets), and ROA (measured by EBIT divided by total assets).

Because of all the criteria, Q1's final sample comprises 35 target companies and 20 control firms, whereas Q2's final sample is composed of 43 target companies and 33 control firms, and Q3's final sample encompasses 20 target companies and 15 control firms⁶.

Lastly, with the matchings accomplished and the samples concluded, a DiD analysis was undertaken for the pandemic impact on PE portfolio companies' performance regarding the first research question, the performance recovery of PE portfolio companies from the pandemic, respecting the second research question, and the performance recovery from the pre- to the post-pandemic period of PE portfolio companies, concerning the third research question.

To support the robustness of the matching procedure, Equation (3.3) was also estimated in these robustness checks. This applies to the three different studies being conducted throughout this dissertation.

Interpreting the evolution of the various dependent variables regarding the sample of Q1, represented in Figure 6, it is revealed that the performance of the treatment and the control groups does not diverge before the onset of the pandemic. An exception to this pattern is observed in the case of Assets, where a slight divergence between PE and non-PE portfolio companies emerges before the pandemic period.

⁶ PSM allowed an improvement of the quality of the samples, even though with the trade-off of a decrease in the number of observations. As a result, the samples of PE and control companies of each research question are more similar, as can be observed in Appendix A –Samples (PE-backed and Control companies) comparison with robustness check.

Figure 6 - Effect of PE ownership on firm performance during the COVID-19 pandemic (sample of the first research question with robustness check)

Figure 6 presents the effect of PE ownership on firm performance during the COVID-19 pandemic, focusing on the four dependent variables of this study (Sales, Assets, Employment, and Earnings). This figure reports the α_t of Equation (3.3) where α_t captures the year fixed effects and α_i captures the firm fixed effects. The year before the pandemic, 2019, is the basis period, and its corresponding coefficient is normalized to zero. The equation is estimated separately for both the PE-backed and control firms, with standard errors clustered at the company level. The matching between PE and control groups was performed through the PSM. All the variables are winsorized at the 1% level.

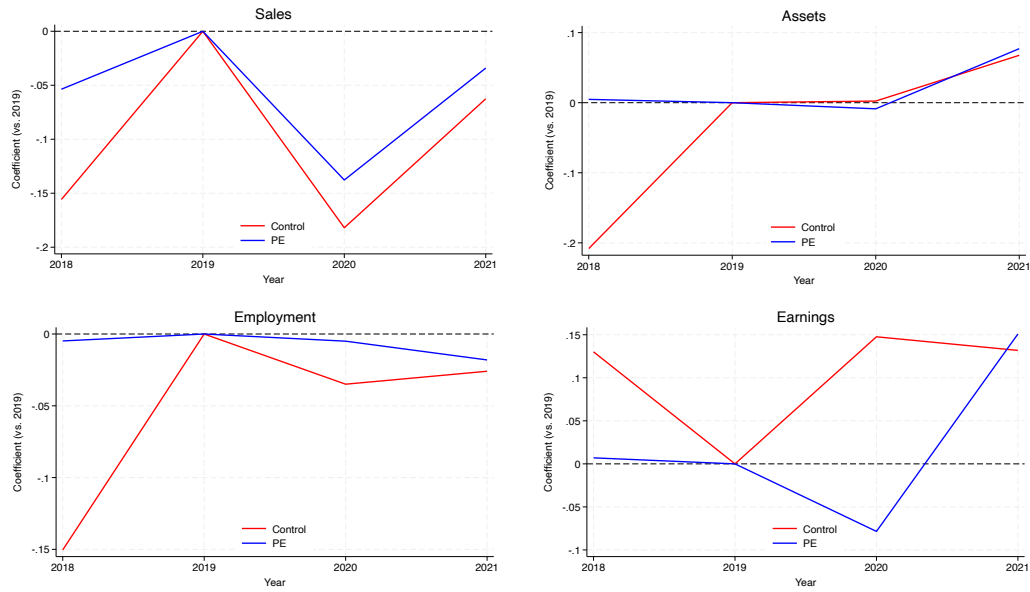
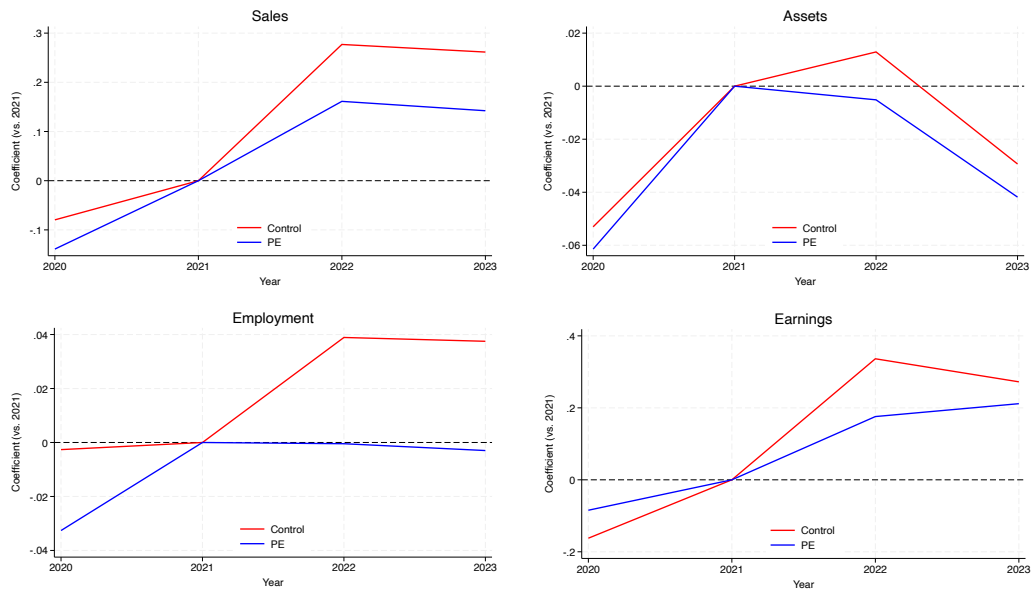


Figure 7 illustrates that the trajectories of the dependent variables, with respect to the sample of Q2, remain largely aligned between the treatment and control groups during the pandemic period. This observation supports the effectiveness of the matching methodology in establishing during-pandemic equivalence between the two groups.

Figure 7 - Effect of PE ownership on firm performance during the post-COVID-19 pandemic (sample of the second research question with robustness check)

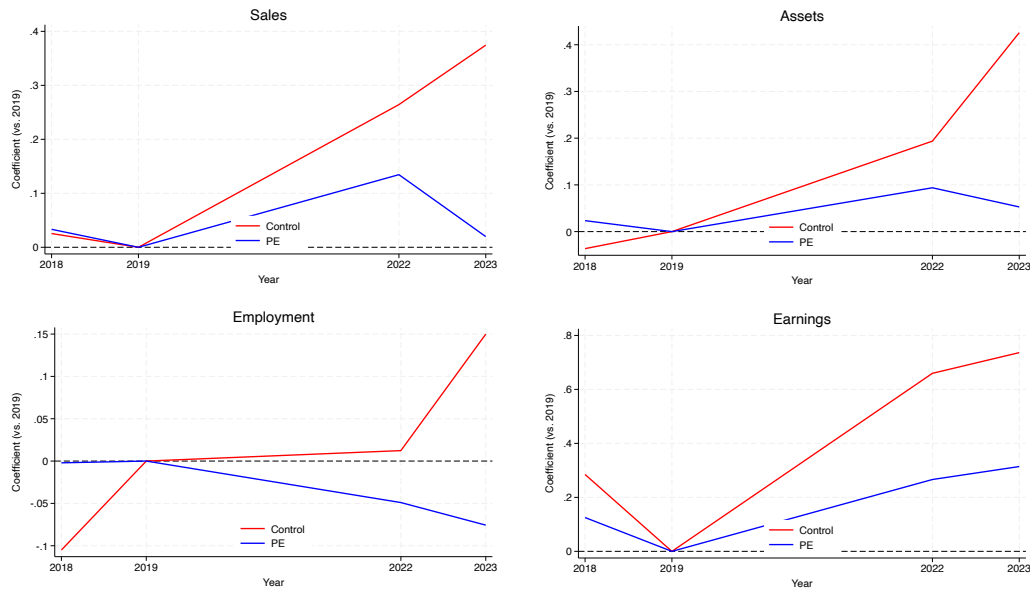
Figure 7 presents the effect of PE ownership on firm performance during the post-COVID-19 pandemic, focusing on the four dependent variables of this study (Sales, Assets, Employment, and Earnings). This figure reports the α_t of Equation (3.3) where α_t captures the year fixed effects and α_i captures the firm fixed effects. The year before the post-pandemic, 2021, is the basis period, and its corresponding coefficient is normalized to zero. The equation is estimated separately for both the PE-backed and control firms, with standard errors clustered at the company level. The matching between PE and control groups was performed through the PSM. All the variables are winsorized at the 1% level.



As illustrated in Figure 8, the evolution across the dependent variables, regarding the sample of Q3, reveals that, in general, there is no divergence in performance between the treatment and control groups during the pre-pandemic period, except for the Assets variable. In fact, the divergences before the pandemic that occurred in Employment and Earnings in the multivariate regression (Section 3.5.3) were corrected through the new applied matching procedure, PSM.

Figure 8 - Effect of PE ownership on firm performance during the post-COVID-19 pandemic (sample of the third research question with robustness check)

Figure 8 presents the effect of PE ownership on firm performance during the COVID-19 pandemic, focusing on the four dependent variables of this study (Sales, Assets, Employment, and Earnings). This figure reports the α_t of Equation (3.3) where α_t captures the year fixed effects and α_i captures the firm fixed effects. The year before the pandemic, 2019, is the basis period, and its corresponding coefficient is normalized to zero. The equation is estimated separately for both the PE-backed and control firms, with standard errors clustered at the company level. The matching between PE and control groups was performed through the PSM. All the variables are winsorized at the 1% level.



4.4.1. Pandemic Impact on PE Portfolio Companies' Performance

Centering on the first research question, and as shown in Panel A of Table 11, the COVID-19 pandemic had a higher negative impact on PE-backed companies' sales compared to control companies. During the COVID-19 pandemic, sales of PE portfolio companies decreased by €4.1 million more than those of non-PE-backed companies (at a 10% significance level). Additionally, PE-backed companies decreased the number of employees by approximately 52 more than their matched companies (at a 10% confidence level) during the pandemic period.

Table 11 - Firm performance during the pandemic (with robustness check)

Panel A of Table 11 presents the results from the baseline DiD model, Equation (3.1). PE_i is a dummy variable that equals one for PE-backed companies and zero for the control group. $Post_i$ is a dummy variable that equals one for observations during the period of 2020 and 2021, and zero in the pre-pandemic years, 2018 and 2019. Panel B shows the estimates from Equation (3.2), using the pre-pandemic period, 2018 to 2019, as the reference period. All the variables (except for firm age) are winsorized at the 1% level. The Newey-West estimator was applied, and the standard errors are presented in parentheses. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

	Sales	Assets	Employment	Earnings
Panel A: Baseline differences-in-differences				
PE*Post	-4,079,278* (2,243,083)	-2,344,408 (1,773,581)	-52.18* (31.82)	-240,760 (477,675.60)
Panel B: Year-by-year effects				
PE*2020	-4,424,277** (2,233,290)	-2,680,895 (2,090,772)	-34.30* (20.76)	-752,695.60 (474,353.50)
PE*2021	-3,817,093 (3,986,036)	-2,065,971 (1,608,028)	-82.65* (48.36)	526,141.90 (640,129.80)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	231	231	231	231

Furthermore, analyzing Panel B of Table 11, shows that from the pre-pandemic period to 2020, sales of PE portfolio companies decreased statistically significantly more than those of control companies. Additionally, from the pre-pandemic period to 2020 and to 2021, employment of target companies decreased statistically significantly more than that of control firms.

Ultimately, focusing on Q1, it can be concluded that both sales and employment of PE portfolio companies were more negatively impacted by the COVID-19 pandemic than those of control firms.

4.4.2. Performance Recovery of PE Portfolio Companies from the Pandemic

Focusing on the second research question, upon analyzing Panel A of Table 12, there is no statistically significant effect of being backed by PE compared to control companies in the recovery from the pandemic on the four studied dimensions of these companies.

Table 12 - Firm performance during the post-pandemic (with robustness check)

Panel A of Table 12 presents the results from the baseline DiD model, Equation (3.1). PE_i is a dummy variable that equals one for PE-backed companies and zero for the control group. $Post_i$ is a dummy variable that equals one for observations during the period of 2022 and 2023, and zero in the pandemic years, 2020 and 2021. Panel B shows the estimates from Equation (3.2), using the pandemic period, 2020 to 2021, as the reference period. All the variables (except for firm age) are winsorized at the 1% level. The Newey-West estimator was applied, and the standard errors are presented in parentheses. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

	Sales	Assets	Employment	Earnings
Panel A: Baseline differences-in-differences				
PE*Post	-1,737,204 (3,505,355)	-5,075,766 (3,861,158)	0.08 (9.34)	-1,095,255 (748,417)
Panel B: Year-by-year effects				
PE*2022	-2,738,443 (3,640,015)	-4,896,490* (3,052,389)	-0.43 (6.87)	-1,208,046 (875,507.80)
PE*2023	-692,237.20 (3,738,826)	-6,963,929* (4,449,518)	-0.82 (11.18)	-1,089,296 (901,071.60)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	295	295	295	295

Regarding year-by-year effects, from Panel B of Table 12, it can be concluded that from the pandemic period to 2022 and 2023, the assets of PE-backed companies increased statistically significantly less than those of control firms.

Hence, centering on Q2, it is crucial to underline that, regarding year-by-year effects, assets of PE portfolio companies presented a slower recovery from the pandemic than those of non-PE-backed counterparts.

4.4.3. Pre- and Post-Pandemic Performance Comparison of PE Portfolio Companies

Concentrating on the third research question, according to Panel A of Table 13, no statistically significant differences during the post-pandemic period are observed between target and control firms across the four examined dimensions.

Table 13 - Firm performance during the post-pandemic (with robustness check)

Panel A of Table 13 presents the results from the baseline DiD model, Equation (3.1). PE_i is a dummy variable that equals one for PE-backed companies and zero for the control group. $Post_t$ is a dummy variable that equals one for observations during the period of 2022 and 2023, and zero in the pre-pandemic years, 2018 and 2019. Panel B shows the estimates from Equation (3.2), using the pre-pandemic period, 2018 to 2019, as the reference period. All the variables (except for firm age) are winsorized at the 1% level. The Newey-West estimator was applied, and the standard errors are presented in parentheses. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

	Sales	Assets	Employment	Earnings
Panel A: Baseline differences-in-differences				
PE*Post	-3,648,184.00 (5,037,572)	-4,154,090 (3,663,953)	74.30 (82.08)	-163,626.10 (443,412.40)
Panel B: Year-by-year effects				
PE*2022	-1,133,077 (6,369,024)	-1,536,270 (2,693,785)	129.10 (100.99)	-432,044.90 (513,772.20)
PE*2023	-5,446,126 (8,199,204)	-7,040,385 (5,692,802)	-4.81 (37.99)	450,826.70 (693,212.20)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	133	133	133	133

With regard to year-by-year effects, Panel B of Table 13 shows there is no statistical significance in any coefficient, which suggests that there is no statistical significance between PE and non-PE portfolio companies' recovery trajectories from the pre- to the post-pandemic period.

5. Conclusion

The present dissertation studies the impact of PE ownership on companies' operating performance during crisis periods in Portugal, using a DiD model. More specifically, this research analyses the impact of the COVID-19 pandemic, and subsequent recovery, on the operating performance of Portuguese PE-, when compared to non-PE-backed companies.

In general, analyzing PE-backed and non-PE-backed companies together, from the pre- to the pandemic period, it was observed a decrease in total cash and cash-to-assets ratio, along with an increase in ROA. Subsequently, it was also concluded that there was a decrease in sales, EBITDA, and ROA from the pandemic to the post-pandemic period. Additionally, during the transition from the pre- to the post-pandemic periods, a decrease was noted in total assets, total cash, sales, EBITDA, and the cash-to-assets ratio.

But most importantly, the results of the DiD model suggest that, when comparing the pre- and pandemic periods, sales, assets, and employment of PE portfolio companies were more negatively impacted than those of non-PE-backed companies. Furthermore, when analyzing the pandemic and its post-period, it was also noted a slower recovery of assets of PE-backed firms from this negative shock, compared to that of control firms. Finally, the comparison between the performance during the pre- and post-pandemic periods demonstrates a slower recovery of assets and the number of employees of PE portfolio companies when compared with those of non-PE portfolio companies.

Additionally, tests to ensure the validity of the baseline results were performed, using PSM, and the results corroborated these conclusions, i.e., that, across the analyzed metrics of firm performance, PE-backed firms tend to be more negatively impacted by the pandemic, presenting a slower recovery, compared to similar firms or, at best, this impact is neutral.

These results are contrary to most of the literature that studies PE performance during crisis periods (Bernstein et al., 2020; Lavery & Wilson, 2024a; Lavery et al., 2024), which shows the need to study smaller or less-developed markets to better understand the dynamics of PE's impact.

The main limitation of this dissertation is the limited sample size, which is a consequence of focusing on a relatively small country, Portugal, where the PE sector is not yet firmly established.

Further research could compare the performance of PE companies in contrast with that of VC firms, focusing on both during and after the pandemic periods. Additionally, studying the impact of the pandemic on the capital structure of both PE and non-PE portfolio companies could complement the present study. Finally, studying the performance of PE-backed firms that were acquired during the pandemic period, compared with the performance of control companies, during both the pandemic and post-pandemic periods, could be future research to be pursued.

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Appendix A – Samples (PE-backed and Control companies) comparison with robustness check

Table A1 - Characteristics of PE and control samples in 2019 (sample of the first research question) (with robustness check)

Table A1 reports summary statistics for the pre-pandemic year (2019) of PE and control samples, as well as the difference between the mean and median values of the two samples, after using PSM to create the matchings between the target companies and the control firms. PE refers to all the PE-backed companies, whereas Control refers to a sample of non-PE-backed companies, matched on their first two-digit US SIC codes, total assets, ROA (EBIT/total assets), and leverage (total debt/total assets) within a 30% bracket (regarding total assets and ROA) and 15 percentage point bandwidth (respecting leverage) in the pre-pandemic year, considering that exceptionally, when these criteria did not produce results, the ROA criterion was adjusted to a bandwidth of 3 percentage points. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the PE sample are significantly different from the Control sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	PE						Control						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	35	34	34	22	3	194	20	25	25	26	3	55	9	-4
Employment (n)	35	125	125	94	0	404	20	244	244	64	3	1,792	-119	30
Total Assets (€000)	35	27,500	27,500	13,700	1,619	120,000	20	33,300	33,300	19,900	2,176	143,000	-5,800	-6,200
Total Debt (€000)	35	11,100	11,100	3,662	0	64,800	20	14,700	14,700	5,123	0	58,600	-3,600	-1,461
Total Cash (€000)	35	834	834	326	1	3,892	20	1,963	1,963	528	15	12,100	-1,129	-202
Sales (€000)	35	25,600	25,600	9,214	0	216,000	20	31,700	31,700	6,676	769	154,000	-6,100	2,538
EBITDA (€000)	35	2,192	2,192	769	-1,977	11,100	20	2,215	2,215	829	-642	12,200	-23	-60
Panel B														
Return On Assets	35	0.02	0.02	0.03	-0.21	0.21	20	0.02	0.02	0.04	-0.21	0.11	0.00	-0.01
Leverage	35	0.36	0.36	0.36	0.00	0.79	20	0.39	0.39	0.36	0.00	0.95	-0.03	0.00
EBITDA Margin	35	0.12	0.12	0.08	-0.26	0.52	20	0.08	0.08	0.07	-0.18	0.40	0.04	0.00
Cash/Assets	35	0.05	0.05	0.02	0.00	0.46	20	0.12	0.12	0.05	0.00	0.50	-0.07**	-0.03
Debt/EBITDA	35	9.03	9.03	4.56	-23.39	74.31	20	3.62	3.62	4.01	-52.63	50.72	5.41	0.56

(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are PE values less Control values.

Table A2 - Characteristics of PE and control samples in 2021 (sample of the second research question) (with robustness check)

Table A2 reports summary statistics for the pre-post-pandemic year (2021) of PE and control samples, as well as the difference between the mean and median values of the two samples, after using PSM to create the matchings between the target companies and the control firms. PE refers to all the PE-backed companies, whereas Control refers to a sample of non-PE-backed companies, matched on their first two-digit US SIC codes, total assets, ROA (EBIT/total assets), and leverage (total debt/total assets) within a 30% bracket (regarding total assets and ROA) and 15 percentage point bandwidth (respecting leverage) in the pre-post-pandemic year, considering that exceptionally, when these criteria did not produce results, the ROA criterion was adjusted to a bandwidth of 3 percentage points. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the PE sample are significantly different from the Control sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	PE						Control						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	43	29	29	23	8	103	33	27	27	26	4	75	2	-3
Employment (n)	43	98	98	76	0	397	33	112	112	62	0	623	-13	14
Total Assets (€000)	43	67,000	67,000	16,100	973	780,000	33	51,600	51,600	9,680	1,920	768,000	15,400	6,420*
Total Debt (€000)	43	36,600	36,600	4,778	0	557,000	33	33,100	33,100	2,715	0	601,000	3,500	2,063
Total Cash (€000)	43	3,325	3,325	826	0	36,600	33	2,073	2,073	700	23	14,100	1,252	125
Sales (€000)	43	21,800	21,800	9,785	1,084	176,000	33	15,300	15,300	10,800	111	145,000	6,500	-1,015
EBITDA (€000)	43	3,792	3,792	1,651	-3,898	55,000	33	5,306	5,306	1,094	-780	65,400	-1,514	557
Panel B														
Return On Assets	43	0.05	0.05	0.04	-0.17	0.28	33	0.05	0.05	0.06	-0.13	0.29	0.00	-0.01
Leverage	43	0.35	0.35	0.34	0.00	1.33	33	0.37	0.37	0.34	0.00	1.28	-0.02	0.00
EBITDA Margin	43	0.18	0.18	0.11	-2.34	2.41	33	0.22	0.22	0.15	-3.27	5.47	-0.04	-0.04
Cash/Assets	43	0.11	0.11	0.06	0.00	0.68	33	0.12	0.12	0.08	0.00	0.42	0.00	-0.02
Debt/EBITDA	43	1.71	1.71	2.85	-290.62	99.92	33	3.63	3.63	3.31	-30.36	50.66	-1.92	-0.46

(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are PE values less Control values.

Table A3 - Characteristics of PE and control samples in 2019 (sample of the third research question) (with robustness check)

Table A3 reports summary statistics for the pre-pandemic year (2019) of PE and control samples, as well as the difference between the mean and median values of the two samples, after using PSM to create the matchings between the target companies and the control firms. PE refers to all the PE-backed companies, whereas Control refers to a sample of non-PE-backed companies, matched on their first two-digit US SIC codes, total assets, ROA (EBIT/total assets), and leverage (total debt/total assets) within a 30% bracket (regarding total assets and ROA) and 15 percentage point bandwidth (respecting leverage) in the pre-pandemic year, considering that exceptionally, when these criteria did not produce results, the ROA criterion was adjusted to a bandwidth of 3 percentage points. The two-tailed T-student test and Wilcoxon Rank-Sum (Mann-Whitney U Test) were performed to assess whether the median and mean, respectively, of the PE sample are significantly different from the Control sample. Significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively.

Variables	PE						Control						Difference (b)	
	N	Mean	Mean (a)	Median	Min	Max	N	Mean	Mean (a)	Median	Min	Max	Mean (a)	Median
Panel A														
Firm Age (years)	20	31	31	24	10	101	15	37	37	34	13	108	-7	-10
Employment (n)	20	106	106	75	9	404	15	419	419	63	6	4,954	-313	12
Total Assets (€000)	20	25,900	25,900	12,500	1,619	120,000	15	24,900	24,900	10,800	2,558	143,000	1,000	1,700
Total Debt (€000)	20	9,244	9,244	3,590	0	59,600	15	9,240	9,240	3,413	0	58,600	4	177
Total Cash (€000)	20	672	672	284	1	3,892	15	543	543	215	15	3,055	129	68
Sales (€000)	20	32,500	32,500	9,074	1,498	216,000	15	21,500	21,500	6,021	272	154,000	11,000	3,053
EBITDA (€000)	20	2,219	2,219	649	-171	9,953	15	2,017	2,017	646	-499	11,200	201	3
Panel B														
Return On Assets	20	0.03	0.03	0.04	-0.07	0.11	15	0.05	0.05	0.06	-0.05	0.10	-0.02	-0.02
Leverage	20	0.33	0.33	0.34	0.00	0.54	15	0.31	0.31	0.20	0.00	1.21	0.02	0.13
EBITDA Margin	20	0.11	0.11	0.07	-0.11	0.35	15	0.02	0.02	0.12	-1.84	0.32	0.09	-0.05
Cash/Assets	20	0.06	0.06	0.02	0.00	0.46	15	0.03	0.03	0.02	0.00	0.15	0.03	0.00
Debt/EBITDA	20	8.74	8.74	4.43	-23.39	74.31	15	16.61	16.61	5.93	-3.33	170.24	-7.87	-1.50

(a) Mean values shown (except for firm age) are after the winsorize (1%/99% level) transformation.

(b) Difference values are PE values less Control values.