

Bocconi University Thesis

Leveraged Buyouts and Probability of Default: Empirical Analysis of the General Effect of LBOs on Altman Z-Score

Stockholm School of Economics Thesis

MBOs, IBOs and Default Risk: an analysis on the different effects of management and institutional buyouts on targets' Altman Z-Score

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Introduction

Since the early 1980s, the phenomenon of leveraged buyout (“LBO”) has garnered increasing interest in academic literature. One of the main features of these transactions, which differentiates them from other types of investments carried out by funds, is the use of debt. Over the years, academic research has focused on examining LBO’s underlying dynamics in governance structures, direct and indirect value creation mechanisms, and investment strategy’s outcomes in terms of returns. In addition, the literature has delved into the impact of LBOs on target companies, particularly concerning their performance metrics and bankruptcy rates.

In this regard, on one hand, the theory of Jensen (1989) attributes a positive role to debt, arguing that it has a disciplinary effect that aligns the interests of managers and owners, thereby decreasing agency costs. Such a perspective suggests that LBOs reduce the default risk of target companies. On the other hand, Axelson, Jenkinson, Strömberg and Weisbach (2013) argue that private equity investors do not use an amount of debt suitable and appropriate for the company but are inclined to use more leverage (and to overpay for deals) the greater the accessibility and cheapness in the debt market. This opportunistic use of leverage, especially when debt costs are low, would suggest that LBOs increase the company’s risk of default.

This research aims to empirically examine which of these effects is prevalent by investigating the impact of leveraged buyouts on the default probability of target companies. To this end, the study considers the Altman Z-Score as an estimate of default probability and employ the difference-in-differences methodology. The sample is constructed by identifying a peer for each target company, through a precise matching mechanism. Subsequently, financial data of the year prior to the LBO are compared with those recorded three years after the transaction, for both target and peer groups. In addition to analysing the impact of LBOs on the overall Altman Z-Score, the study examines the impact on each of its components. Finally, the research explores how variables accounting for the LBO effect contribute to the Altman Z-Score’s formula definition.

Guided by this objective, the study unfolds into 4 chapters which provide a comprehensive analysis from theoretical foundations to empirical results.

The first chapter outlines the context of private equity, then focuses on leveraged buyouts, their classification, historical development, and value creation strategies. It concludes with an overview of the Altman Z-Score, its accounting foundations, and its relevance in estimating default probability.

The second chapter reviews empirical evidence suggesting both positive and negative impacts of LBOs on probability of default of the targets. Following this review, the chapter focuses on formulating the research questions that guide the subsequent analysis.

The third chapter describes the data selection procedure for transactions and control group samples. It then introduces the difference-in-differences methodology, explaining and verifying the assumption underlying the validity of this technique.

The fourth chapter delves into the empirical results, starting with the effect of LBOs on the Altman Z-Score. It further examines the impact on the individual components of the score, linking the findings to theoretical considerations and strategies of value creation. It finally analyses an extended model that connects the Altman Z-Score with its traditional four components and with additional variables capturing the LBO effect.

The final part draws conclusions from the study, discussing its limitations and outlining the space for future research.

1. Theoretical Framework

1.1. Private Equity

Private equity ("PE") can be defined as the activity of investing capital in private companies in exchange for equity. Public companies, i.e. companies listed on a stock exchange, can also be purchased by a private investor; under these circumstances the company becomes private, and this is known as de-listing. As of 31 March 2023, the private equity industry reported a total AUM¹ of USD 8 Trillion².

From the perspective of the company being invested in ("target"), private equity can be viewed as an alternative form of financing to classic types of borrowing. On the contrary, for the investor, typically a private equity fund, private equity activity takes the form of an investment with a defined duration, which must generate a return in the medium to long term. The bi-univocity of these perspectives results in a strict relationship between the investor and the company (Caselli & Negri, 2019), that practitioners define as "marriage but with an end".

Private equity investment is not limited to merely the provision of money but includes the contributions of many non-financial factors that, while hard to measure, are the true essence of the investment and are critical to the growth of the company. Some of these include, for example, the following:

- *Certification*: since the investor chooses the target following an extensive screening phase, after the acquisition, the value and potential of the company is signalled to the market.
- *Network*: the investor shares with the company a broad network of suppliers, customers, and lenders.
- *Soft and Hard Knowledge*: given his experience in running businesses, the investor can transfer skills in management together with knowledge in the specific field.

¹ AUM (Assets Under Management) refers to the financial assets that a fund manager invests on behalf of investors.

² Data exported in November 2023 from Preqin.

In addition to them, through the involvement of the investor, the company indirectly benefits from strategic and financial advisory services, as well as support in the processes of monitoring and measuring results.

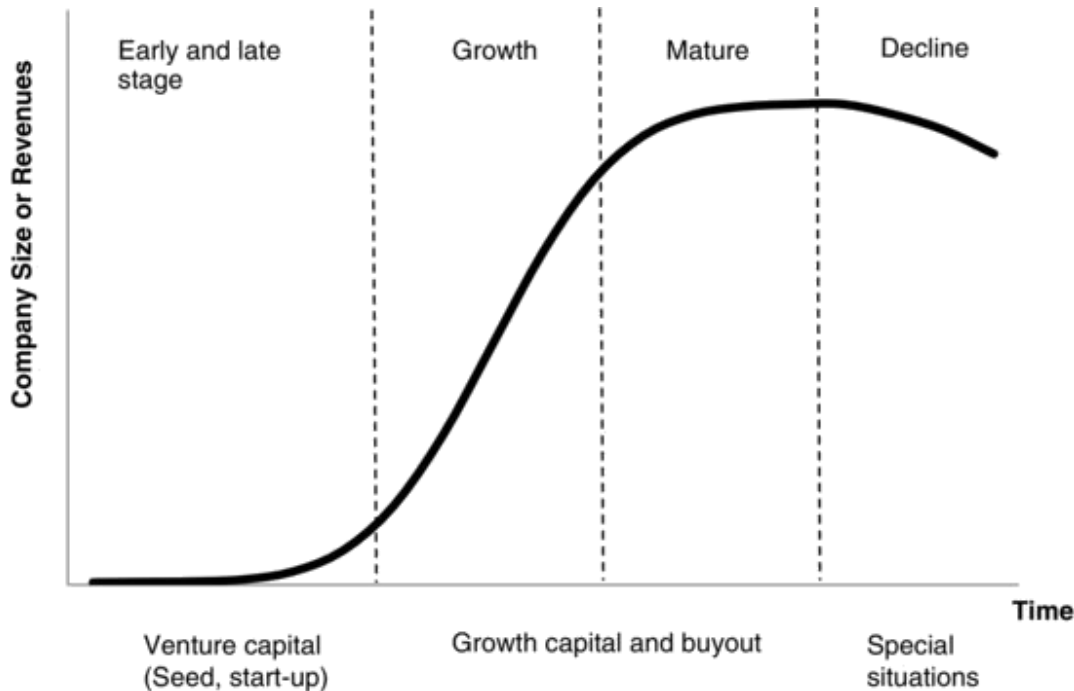
As for the capital provided, it can be deployed to sustain the start-up phases of the company, its development plans, business acquisitions, generational takeovers, operational turnarounds, and more. This is precisely the reason why private equity potentially covers all types of companies, applying different solutions for each of the purposes for which the investment is made. Indeed, depending on the life cycle the company is through, there is a substantial difference both in terms of the business's needs to be met and risk-return profile expected by the investor. To this end, among the various approaches that can be taken in defining private equity activities, most of the literature focuses on the company's stage of development and its financial needs. Therefore, following the classification proposed in the literature, four macro categories of private equity investment strategies can be identified, namely venture capital, growth capital, buyout, and special situations.

- *Venture Capital*: it concerns investments in start-ups or early-stage companies that have potentially exponential growth profiles. The goal is to support companies that are still in the product development or market penetration phase, and for this reason the fund's investment aims to finance the companies' research, development, and initial expansion. The risks are higher than investments in more mature companies, as many start-ups may not be successful. On the other side, the potential return is also higher.
- *Growth Capital*: in this type of strategy, the fund buys a minority or in any case noncontrolling stake, preferring to implement a passive approach. Two other factors that distinguish this strategy are the status of the company, which is in a purely expansion phase, and the moderate use of leverage. The goal is to finance growth, which may involve, for example, gaining market share through geographic expansion, product innovation, and so on.
- *Buyout*: in this case the fund invests in an established and mature company, with the intention of improving operations and/or financials. The investor, therefore, takes part at the forefront of the company's strategic choices. Often in this type of

investment there is intensive use of debt, and in such a case this is referred to as a leveraged buyout, which is the main subject of this research.

- *Special Situations*: this strategy aims to restructure the finances of mature companies that have a good business model but are going through a difficult phase. In this case, the fund's return is particularly determined by buying at a discount.

Figure 1. Private equity strategies by Company Life Cycle



Source: Iverson (2013)

In the current study, the term investor will refer to the private equity fund, which is the player that is typically involved directly or indirectly in these transactions. Thus, before moving into the analysis of leverage buyouts, it is important to define some of the general dynamics governing a private equity fund, particularly those related to the structure, timing, and remuneration of the fund.

Regarding the structure of the private equity fund, generally it consists of a limited partnership. It involves two categories of actors, limited partners, and general partners. The former are in most of the cases institutional and high-net-worth individual investors, who commit their own capital to the structure, while the latter manage the capital, calling it in when necessary, investing it strategically, and distributing it over the fund's lifespan.

As for the fund's timeline, a typical private equity fund operates over a period of 10 to 12 years. During the first half, investments are made, and during the second half they are monitored and managed, scheduling the exit and trying to maximize returns for investors.

Lastly, about remuneration, the general partners are compensated through management fee and performance fee. The management fee³ covers operating costs, staff salaries, research and other overhead expenses incurred by the fund, while the performance fee⁴ is a share of the profits realized from investments that the fund's general partners receive once a specified return has been achieved. As stated by Chambers, Black and Lacey (2018), this remuneration mechanism follows the concept that as opposed to public markets, most private equity investments cannot be reliably valued until divestments occur. As a result, management fees in private equity are calculated based on the values of the portfolios, and on top of them there are incentive fees that are calculated at divestment time.

1.2. Leveraged Buyout

1.2.1. Fundamentals

A leveraged buyout ("LBO") is the acquisition of a company, division, business, or collection of assets using debt to finance a large portion of the purchase price, the remaining portion is funded with an equity contribution by the acquirer.

Gaining popularity during the 1980s in the United States as a means of defending against hostile takeovers and as a tool for "going private" operations, the LBO concept achieved international notoriety only in 1989, when KKR purchased RJR Nabisco for \$25 bn. An LBO is a type of transaction that can take many different forms and structures, but it always has a set of well-defined characteristics.

Operationally, a group of actors interested in buying a control stake in the target company finds third-party financial resources that will be raised within a specially

³ Usually expressed as a yearly rate and ranges between 1 percent and 2 percent of the total amount of capital committed.

⁴ It is calculated by applying a percentage (15 percent to 25 percent) on capital gains, sometimes calculated in excess of a rate called the "hurdle rate".

created company (bidco or newco) to complete the purchase transaction. The repayment of the debt underwritten by the new entity is usually guaranteed by the assets of the target and supported by the cash flow generated by it, or by the proceeds from the sale of certain assets deemed no longer strategic. After the acquisition, the target company and the new entity merge; in this way, the debt assumed by the new company is consolidated in the target.

In conclusion, the distinctive feature of this transaction is the coexistence of two characterizing elements:

- 1) Change in ownership structure ("buyout"): the buyer obtains control of the target company, be it majority or total control.
- 2) Extensive use of debt ("leverage"): comprehensive restructuring of the capital structure of the target.

In addition, a third feature concerns the specific attributes commonly found in LBO target candidates. With that in mind, the following sections will outline each of these three peculiar aspects of the LBO transaction.

1.2.1.1. Buyout classification

Regarding the point 1), based on the actor originating the acquisition process and the overall purpose, several forms of buyout can be distinguished:

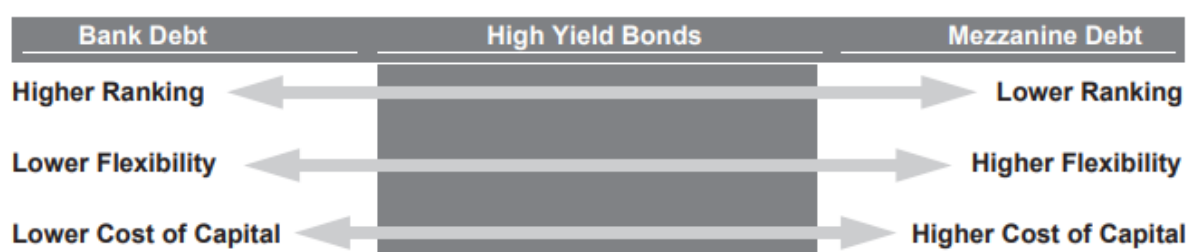
- *Institutional Buyout* (IBO): the transaction is realized by a financial investor, typically a private equity fund, which, once identified the target company, acquires its control stakes.
- *Management Buyout* (MBO): the deal is originated by the target company's management, helped by a financial investor, often a private equity fund, which provides capital support and access to debt financing through established relationships with investment banks.
- *Management buy-in* (MBI): in this case, managers involved in the buy-in process are external to the target company but have the expertise to manage it. Specifically, the managers often come from industries close to the sector in which the target company operates.

- *Buy-in Management Buyout* (BIMBO): there is simultaneous promotion of the deal by management inside and outside the company.
- *Worker Buyout* (WBO): it involves the entry of the target company's employees into the shareholding structure.
- *Family Buyout* (FBO): it consists of a transaction where some family members increase their ownership stake in the company by purchasing shares or ownership interests from other outgoing family members.
- *Buy in growth opportunities* (BINGO): the acquirer invests more than the actual value of the company. Excess funds are used to finance attractive growth opportunities.

1.2.1.2. Financing structure

In relation to point 2), a variety of debt instruments can be utilized to finance the leveraged buyouts, among which bank debt, high yield bonds, and mezzanine debt are prominent. As illustrated in Figure 2, each instrument presents distinctions in seniority⁵ (or ranking), flexibility⁶, and, consequently, cost. Generally, the cost of capital tends to have a direct relationship with the flexibility associated with the debt instrument and an inverse relationship with its seniority.

Figure 2. Main LBOs financing instruments' characteristics



Source: Pearl and Rosenbaum (2013)

Concerning bank debt, it is also referred to as "senior secured credit facility". Although cases of bilateral loans exist, most of them are issued through collaborations of pool of banks, often organized as club deals or through syndicated loans. This type of

⁵ Seniority refers to the priority in which each creditor relies on the debtor's assets in the event of insolvency. Debt is termed "senior" when it is repaid first in the debtor's liquidation, while "junior" debt refers to instruments with repayment subordinate to the "senior" debt.

⁶ The concept of flexibility is inversely related to the presence of covenants. A covenant is a contractual clause designed to mitigate risk for the lender and regulate the use of secured debt.

financing can take the form of a revolving line of credit or a term loan, with collateral⁷ and covenants in place to safeguard lenders' interests.

On the other hand, high-yield bonds are non-investment grade notes that require regular interest payments from the issuer to bondholders. Unlike term loans, they do not require periodic repayments of principal, but a full repayment at maturity. Because they are riskier due to their subordinate position in the capital structure and they offer less stringent lending conditions, high-yield bonds generally carry higher interest rates than bank loans. Typically, they are used alongside bank debt to increase leverage levels, facilitating higher purchase prices and/or lower equity contributions. Overall, high-yield bonds offer more flexibility than bank debt, with less restrictive covenants, longer maturities, and no mandatory amortization.

Finally, mezzanine debt is an instrument that falls in between traditional debt and equity, with terms customized through negotiation between the issuer and the lender, offering flexibility to both parties. It allows investors to increase leverage and purchase prices when other sources of capital are not available. For example, it can replace or supplement high-yield financing in adverse market conditions, particularly for smaller companies that do not meet high-yield bond market thresholds. As for its cost, mezzanine debt offers investors higher yields than traditional high-yield bonds and they can be structured to provide upside equity potential through detachable warrants exchangeable for the issuer's common stock. Mezzanine debt interest rates typically involve a mix of cash and non-cash PIK payments, and maturities vary widely, but are often in line with those of high-yield bonds.

As will be further explored later, over the years, the financing structure of LBOs has undergone significant transformations, mainly influenced by changes in financial market conditions and investors' landscape. These changing conditions have impacted leverage levels, purchase multiples, allocation of capital from various classes of debt, and the percentage of equity contribution.

⁷ Usually represented by assets, and/or shares of the target company offered by the investor as guarantee to the lender.

1.2.1.3. Characteristics of an LBO Candidate

Regarding the target company characteristics, although private equity investors are highly flexible acquirers who actively search for attractive investment opportunities across a wide range of industries, geographies, and conditions, there are some common traits that arise among traditional leveraged buyout candidates.

To this extent, Pearl and Rosenbaum (2013) identify an ideal target company for LBO transactions based on few key criteria:

- Ability to generate large and, crucially, stable cash flows, thereby ensuring that the company always has sufficient liquid assets to meet its contracted debt. Usually, businesses capable of providing such cash flows fulfil several criteria, including: i) being established companies; ii) operating in mature markets; iii) operating in sectors or market segments in a leadership position; iv) operating in sectors where demand for goods is stable and relatively predictable.
- Low level of debt structure, in order to ensure that it may be possible to place the leverage used for the operation on the target, without resulting in unsustainable debt ratios.
- Potential for growth, both organically and through future complementary acquisitions. A profitable growth in revenue above market rates helps the deal drive high returns, generating more cash available to repay debt while simultaneously increasing EBITDA and enterprise value. Company scale also improves speed and options for exit opportunities⁸.
- Opportunity to improve operational processes, which is typical for those businesses that can be called "sleepy", i.e., those in which management has not yet been able to exploit the company's full potential.
- Presence of a solid capital base in terms of assets, which can constitute collateral, thus reducing losses in case of default. This in turn increases lenders' willingness to provide debt to the target.

⁸ Larger firms tend to benefit from their scale, market share, buying power, and lower risk profile, and often receive a premium valuation over smaller competitors, other conditions being equal.

1.2.2. Historical Evolution

This study will consider a time horizon covering a period from the early 2000s to 2020, hence it is important exploring what the evolution of the LBO phenomenon has been over an even broader horizon, i.e., from its first occurrence until today.

1.2.2.1. From first LBO cycle to Covid-19

Stepping back to the first LBO operations, it has not precisely pinpointed a specific date for their beginning; however, Gaughan (2010) takes as a reference of first LBO transaction the acquisition of Pan-American Steamship Company and Waterman Steamship Company by McLean Industries in 1955. On a broader scale, it is possible to affirm that LBOs experienced their best moment in essentially two periods: between the late 1970s and 1980s in the United States and then, in the rest of the world, between the late 1990s and the early 2000s. The crisis of the following years led to a contraction of these operations until a very important decline was shown in 2009. Subsequently, from 2010 onward, LBO operations gradually recovered. Therefore, LBO expansion periods can be divided into 3 cycles.

- The first cycle began in the 1980s in the U.S. with the explosion of high-yield bonds and ended with KKR's acquisition of RJR Nabisco in 1988 for \$25 billion. High-yield financing's popularity is attributed to its ability to match the flexibility of private debt with the structural advantages of public debt. However, an increase in defaults in LBOs also made investors more aware of the risks of using sources of capital over which they have little control, especially in times of great crisis.
- The second cycle, started in the 1990s, was characterized by the rise of brand-name fund managers of multibillion-dollar size, and by a reduction in leverage levels, with a shift from the use of public subordinated debt to senior bank products. As for the cycle's end, Guo, Hotchkiss and Song (2011) analysed leveraged buyout deals of U.S. companies, with values of at least \$100 million, between January 1990 and July 2006. They found that the number of LBO transactions declined rapidly from 2000 to 2001, due to the dot.com bubble⁹ bursting.

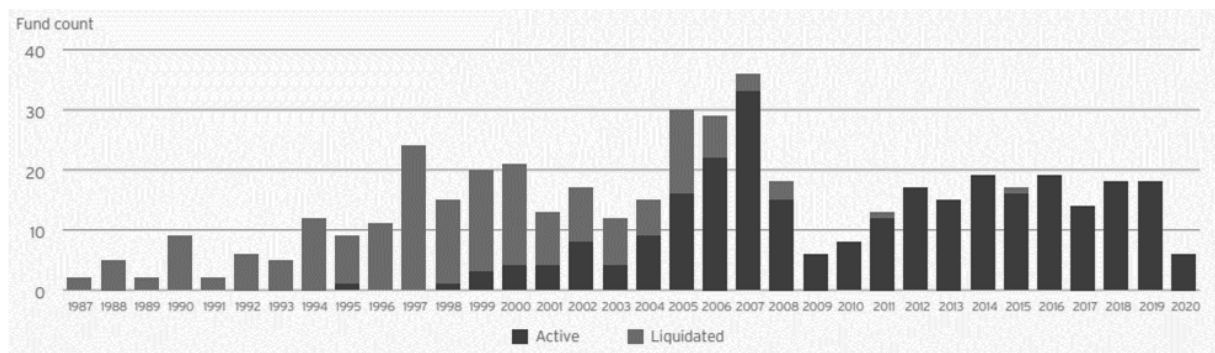
⁹ It has been referred to as a speculative bubble, which developed between 1995 and 2002 and was characterized by the rising stock value of Internet companies and related industries.

- The third cycle lasted from the new economy's outbreak (around 2004) until the credit crunch of 2007-2008. This period is often referred to as the "golden age" of private equity, characterized by a high volume of transactions executed at record multiples. However, market optimism has proven to be misleading to some extent, as most of the mega-deals of that period produced only modest returns, besides being potentially risky for the economy. In this regard, Acharya, Franks and Servaes (2007) highlight the potential risks inherent in these transactions. According to the authors, the expansion of LBOs in the 2000s was driven primarily by the availability of syndicated bank debt. A significant portion of these loans were later traded in the secondary market or assembled into structured financial products. This mechanism had important implications: the banks that originated the loans did not hold the economic risks, thus losing the incentive to effectively monitor the deals and perform due diligence. This potential alleviation of screening activities contributed to the risk of excess credit in the global economy.

Although a fourth cycle has not yet been defined in the literature, an outline of how the LBO phenomenon evolved after the crisis should be mentioned. Gatti, Chiarella, Warren and Ragione (2015) identified the period between 2009 and 2011 as "post-crisis," with limited credit conditions and little opportunity for LBOs due to the drying up of credit markets and the weak economic outlook. In contrast, the 2012-2014 period, labelled as "post-QE," was characterized by limited leverage opportunities (low support for highly leveraged transactions) but at the same time significant deal opportunities due to renewed confidence in the real market, which persisted until 2019. The 2020 brought a drastic change in private equity activity due to the global outbreak of the coronavirus pandemic, which disrupted the economy. This was mainly because commonly introduced regulatory measures interrupted value and supply chains and reduced the demand for various products and services. The shockwave also had a significant impact on financial markets, generating a high degree of volatility. However, differently from 2008, with COVID-19 the credit market maintained its stability and the savings market increased. This key difference was also evidenced in the market recovery. After the events of 2008, it took several years for private equity activity to regain momentum. At this time, on the other hand, a recovery was seen in the third quarter of 2020 already.

As for the history of LBOs in Europe, which is the focus of this research, as can be seen from Figure 3, PE funds first began in the 1980s, but vintages reached an important number of funds by the mid-1990s. From that year on, the pattern has been in line with the general progression previously mentioned.

Figure 3. European LBO funds per vintage year and status



Source: Invest Europe (2023)

1.2.2.2. Current Outlook

The Invest Europe organization each year presents a yearbook illustrating the situation of private equity in Europe. Thus, from the latest available report, "Investing in Europe: Private Equity Activity 2022", it is possible to capture the main data and trends in the fundraising, investments, and divestments of the buyout industry.

Fundraising for buyout transactions in 2022 reached EUR 111 Billion, 51 percent higher than the average of the past five years. In line with past years' breakdown, 151 buyout funds raised capital, with the majority provided by pension funds (34 percent), followed by funds of funds and other asset managers, with 18 percent, and sovereign wealth funds, also with 18 percent. North America was confirmed as the most important source of capital, with 31 percent, followed by Asia and Australia with 26 percent and then United Kingdom and Ireland.

Regarding buyout investments, they reached EUR 81 Billion, marking a 23 percent increase over the average of the past five years. These deals accounted for more than 60 percent of total PE investments for the year. Looking at sectors, ICT received the largest investment (EUR 23 Billion), followed by business products and services (EUR 18 Billion) and consumer goods and services (EUR 17.8 Billion). In terms of geographic distribution of investment by target company location, the regions of France and

Benelux account for 30 percent of the total, followed by the United Kingdom and Ireland with 25 percent. Southern Europe ranks third with 17 percent followed by the DACH region (Germany, Austria, and Switzerland) with 15 percent, the Nordic countries with 11 percent, and finally Central and Eastern Europe (CEE) with 2 percent.

Finally, in 2022 divestments in the buyout sector decreased by 31 percent from the previous year, with a total value of EUR 22.5 Billion. The number of companies divested was 750, down 23 percent from 2021. The main exit channel, both in terms of value and number of companies, was the sale to another private equity firm, accounting for 47 percent and 25 percent respectively. The second most common channel was trade sale¹⁰, accounting for 30 percent in terms of value and 25 percent in terms of number of companies.

1.2.3. Value Creation Levers

Once defined the structure of the LBO transaction, the actors involved, and the historical evolution, a critical step is to analyse what are the different dynamics that the private equity investor leverages to generate value, the latter defined as the difference between the acquisition price (equity value) that is paid at entry, and what it realizes at exit¹¹. More precisely, according to Berg and Gottschalg (2005), equity value is defined as follows:

$$\text{Equity Value} = \text{Val. Multiple} \times \text{Revenue} \times \text{EBITDA Margin} - \text{Net Debt}$$

In this regard, once the entry equity value and exit equity value have been defined, it is possible to decompose the value generated into value drivers. In their article, Berg and Gottschalg (2005) introduce an important distinction between two classes of levers: primary levers, which impact directly on the values of the variables in the equation above, and secondary levers, which have an indirect and positive effect on the main drivers of value creation. Further investigation into the dynamics behind each of the levers will be crucial for the interpretation of the results of this research.

¹⁰ In the context of private equity transactions, a trade sale is defined as the divestment to a strategic investor.

¹¹ It is important to keep in mind that the idea of value creation of PE companies in this case should not be based on synergies as corporates do, unless they pursue a buy-and-build strategy, but rather on enhancing the value of an independent unit.

1.2.3.1. Value Creation: Primary Levers

Regarding primary levers, three macro-variables of value generation can be identified:

- a. Financial engineering
- b. Operating performance improvement
- c. Arbitrage on valuation multiple

a. Financial engineering

As previously mentioned, the presence of substantial debt to finance the transaction is one of the key features of LBOs. The use of financial leverage can deliver higher returns to investors due to two effects.

De-leverage Effect. Known also as the free cash flow (FCF) effect, it refers to the change in the target company's debt after the investor's entry. Normally, as explained earlier, the target company significantly increases the amount of debt on its balance sheet after the LBO transaction. This amount is usually reduced steadily during the holding period using cash flows generated by the firm. At the end of the holding period, following this procedure, the debt level will be significantly lower than the one at beginning, and given the same enterprise value, the equity value will increase due to the reduction in the company's liabilities. Obviously, improvements in the firm's EBITDA, working capital, or capital expenditures also affect FCF and consequently fuel the de-leverage effect. However, even just the ceteris paribus condition allows to capture the effect of deleveraging on value creation.

Tax benefit Effect. Using debt as the main source of financing increases the target company's interest payments. Since these payments are tax deductible, there is value created by the tax benefits of interest (Modigliani & Miller, 1958). These tax benefits directly affect the value of the firm because compared to other forms of remuneration, primarily dividends, they lead to increased free cash flow because of lower taxes (Hayn 1989). Shifting to the cost of capital perspective¹², Damodaran (2008) argues that for the same amount of cash flow generated, through this positive tax effect, a higher debt

¹² $\text{Cost of capital} = \frac{\text{Debt}}{(\text{Debt} + \text{Equity})} \times (1 - \text{tax rate}) \times \text{Pretax Cost of Debt} + \text{Cost of Equity} \times \frac{\text{Equity}}{(\text{Debt} + \text{Equity})}$

component allows the cost of capital to be lowered, and therefore, to increase the value of the firm¹³.

b. Operating performance improvement

Within the company's operational optimization process, the main variable that is evaluated is EBITDA¹⁴. In general, there are two direct sources that have a positive effect on EBITDA (Loos, 2007), namely business growth and markup's increase. The former is reflected in increasing sales, while the latter is influenced by the effect on the EBITDA margin. This separation arises from the concern to distinguish EBITDA growth generated solely by business development (*Revenue Lever*), from the one resulting from increased profitability (*EBITDA Margin Lever*).

Revenue Lever. Frequently one of the priorities of private equity investors is to scale up the business to increase, on a same-margin basis, EBITDA at exit. This objective is pursued through internal and external growth strategies. As for the former, they are implemented when the company can increase its value in-house. As an example, they may involve adding new products or services, improving existing ones or implementing new distribution channels, entering new markets, establishing new partnerships or via strategic repositioning. On top of these, there are strategies for external growth (so-called platform expansion strategies), in which the size of the company is increased through acquisitions. Indeed, sponsors often use their proven track record in mergers and acquisitions to enlarge the size of their portfolio companies.

EBITDA Margin Lever. This effect takes the form of an implementation mainly of 2 possible sub-strategies. On the one hand, margin increase can be achieved by raising selling prices or changing the production mix towards products or services with higher margins. On the other hand, it can be achieved through cost reduction and improved operational efficiency, with the implementation of specific programs aimed at optimizing asset utilization, distribution network, and productivity. Furthermore, margin can be also improved by decreasing bureaucratic and corporate overhead costs,

¹³ Value of Firm = $\sum_{t=1}^{\infty} \frac{\text{Free Cash Flow}_t}{(1+\text{Cost of capital})^t}$

¹⁴ EBITDA stands for Earnings Before Interest, Tax, Depreciation and Amortization.

selling non-core assets, retiring unprofitable products, or reallocating production capacity (Harris, Siegel & Wright 2005).

c. Arbitrage on valuation multiple

Contrary to the effects outlined above, the arbitrage multiple effect is a passive value driver since the private equity firm does not generate value by operating on the target's balance sheet or performance, but rather by exploiting valuation mismatches¹⁵. To this extent, the private equity investor might create value simply by acquiring and selling the asset at two different multiples, although the overall business performance has not changed. This phenomenon is also known as “riding the multiple” (Berg & Gottschalg, 2005). According to Schwetzler (2007), the mechanism driving value creation behind the multiple expansion effect can be attributed prevalently to four factors: evolution of market valuations, access to confidential information, market rumours and investor's ability to negotiate agreements.

Before delving into the discussion of secondary levers for value creation, it is important to clarify that this study will investigate the factors that influence variables related to the targets' balance sheet. Accordingly, the analysis will focus mainly on the dynamics associated to capital structure and business performance, thus considering the levers of financial engineering creation and those related to performance improvement.

1.2.3.2. Value Creation: Secondary Levers

These secondary levers do not have a linear impact on equity value, rather they enhance the effects of primary levers on it. In general, secondary levers are related to changes in organization, corporate governance, and ownership structures. Their main effect is the reduction of agency costs between management and owners (private equity investors) mainly through the alignment of their interests (Jensen, 1986). Among the secondary levers for value creation, the three main ones are as follows.

¹⁵ Consistently with the prior definition of acquisition price, in this study, the term "multiple" specifically pertains to the ratio $\frac{EV}{EBITDA}$

a. Debt disciplining role

Jensen (1986) indicates that in an environment of strong growth and increasing cash flows, corporate executives are more inclined to over-invest rather than distribute dividends to shareholders. High debt levels consequently reduce the free cash flow available, preventing managers from investing in unprofitable projects due to the necessity to cover debt payments. This mechanism significantly reduces agency costs by aligning the interests of managers more closely with those of the shareholders. Additionally, this debt control function also encourages the efficient generation of cash flows (Baker & Wruck, 1989), since failing to meet debt obligations could lead to financial distress, putting the management's reputation under scrutiny.

b. Management incentive mechanism

Easterwood, Seth and Singer (1989) illustrate that post-buyout management's ownership significantly exceeds those of other firms. In this regard, their study highlights how transitioning managers into co-owners fosters both efficiency and the pursuit of highly value-generative investments. Furthermore, Thompson, Wright and Robbie (1992) introduce the concept of "double lock-in", illustrating that managers are incentivized to improve firm performance not solely based on monetary capital they invested, but also due to the commitment of human capital and the inherent incentive to safeguard their position.

c. Change in governance

Following a leveraged buyout, in addition to providing equity stakes, there's also the establishment of new governance structures with the objective to implement advanced reporting and monitoring systems (Acharya, Gottschalg, Hahn & Kehoe, 2013). These mechanisms help in controlling corporate expenses, which are significantly reduced immediately after the acquisition. Furthermore, a strategy for private equity investors to augment oversight consists also in amplifying their presence on either the board of directors or the supervisory board. Consequently, the private equity investor's representatives on the board grant a considerable influence on the strategic direction and executive appointments of the target company.

1.3. Default Prediction Approach

The empirical research that will be outlined in the next chapter analyzes the phenomenon of LBOs, with a focus on the impact of strategies of private equity investors on the default risk of target companies. In this context, it is crucial to define the concept of default referenced, explore the range of methods for default analysis, and describe the Altman model, which will ultimately be the one employed in the study.

1.3.1. Definition of Probability of Default

Prior to introducing the approach for estimating the probability of default used in this study, it should be noted that various definitions of probability of default exist in current literature, and authors define default according to their research topic and objectives. In this research it will be adopted the definition of Resti and Sironi (2021), who define the probability of default as "the likelihood associated with the insolvency of the counterparty, which declares bankruptcy or stops regularly honouring scheduled payments on the loan".

1.3.2. Discriminant Analysis Models and Altman Z-Score

Across the spectrum of models used to estimate the probability of default, credit scoring models have traditionally been the most popular for predicting a firm's insolvency, as the analysis is based on economic and financial indices. Each of these indices is then weighted according to its relative importance in predicting insolvency, leading to a numerical value (score) representative of the probability of default. Scoring models can be clustered into three classes, namely discriminant analysis, regression models (linear, logistic, and probit), and heuristic models (such as neural networks and genetic algorithms). While the first two categories rely on a deductive approach aimed at explaining the economic causes of insolvency, the third category, instead, follows a purely empirical approach.

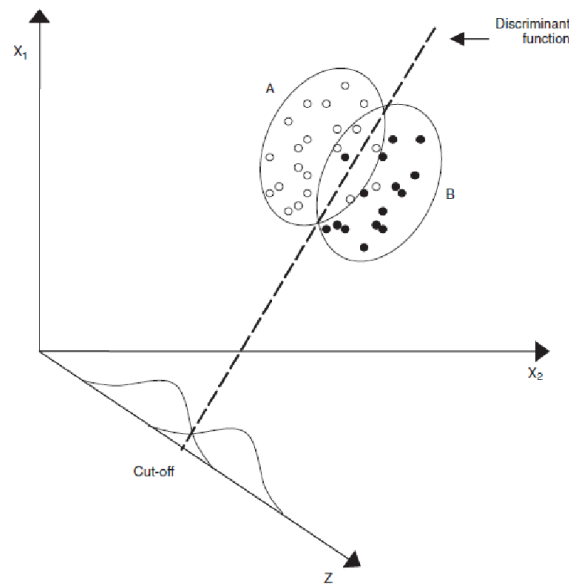
The research will focus on the discriminant analysis, theorized by Fisher (1936), which is based on the identification of variables¹⁶ that better discriminate between "healthy" and "in danger" (or "anomalous") firms. In other words, discriminant analysis draws

¹⁶ Typically accounting-based economic and financial ratios

from a dataset of various companies a boundary between healthy and anomalous firms.

Figure 4 illustrates the Fisher model in the (simplified) case where healthy (group A) and anomalous (group B) companies are described by only two variables, x_1 and x_2 . A score generated by combining the two original variables is represented on the z -axis, and such a score is called discriminant function.

Figure 4. Graphical Summary of Linear Discriminant Analysis



Source: Resti and Sironi (2021)

Discriminant analysis, in its simplest version (linear discriminant analysis) constructs the score from a linear combination of the independent variables (in the case of the figure above, these are x_1 and x_2). In more general terms, given n independent variables, for the generic i -th firm, the score is:

$$z_i = \sum_{j=1}^n x_{ij}y_j$$

Here, the coefficients y_j in the linear combination are selected to obtain a score z that distinguishes as sharply as possible anomalous firms from healthy ones¹⁷.

¹⁷ In other words, the goal is to have the z_i of the "healthy" firms be as similar to each other and as different from the "bad" ones as possible.

As for the calculation of $\bar{y}$ to achieve this objective, it is proven that:

$$\bar{y} = \Sigma^{-1} (\bar{x}_A - \bar{x}_B)$$

Where $\bar{x}_A$ and $\bar{x}_B$ are the vectors of average values of the n independent variables for the groups of “healthy” and “anomalous” firms, respectively, and Σ is the variance-covariance matrix for the n independent variables.

Once $\bar{y}$ and thus the scores for each company are calculated, a threshold a (cut-off point) is determined, below which a firm is deemed too risky. This threshold is defined as follows:

$$a = \frac{1}{2} \bar{y} (\bar{x}_A + \bar{x}_B)$$

1.3.1.1. Altman Z-Score

Following the exposition of the methodology for defining the discriminant score, this study utilizes the most renowned model, theorized by the study Edward I. Altman (1968), which considers five financial ratios as independent variables.

The first balance sheet indices-based approach was developed by Beaver (1966), who firstly found, with a dichotomous classification, that a specific set of indicators could distinguish between samples of healthy and anomalous companies up to five years prior a potential bankruptcy. Altman's Z-Score model refined Beaver's framework by developing a multivariate discriminant analysis (MDA), also reducing the number of indicators from 14 to 5 (related to liquidity, profitability, financial leverage, and solvency), and assigning a weight to each¹⁸. The reason for introducing an MDA is that, for example, a company with low profitability could be classified as potentially insolvent in a dichotomous model. However, if the company has above-average liquidity, the situation might not be considered critical.

Altman's equation for the i -th company is the one defined below.

$$Z_i = 1.2 x_{1,i} + 1.4 x_{2,i} + 3.3 x_{3,i} + 0.6 x_{4,i} + 0.9 x_{5,i}$$

¹⁸ The study's sample consisted of 66 firms, divided between 33 that had failed and 33 that had not, matched by size and industry sector, during from 1946 to 1965.

The independent variables x_1 , x_2 , x_3 , x_4 and x_5 are defined as follows:

x_1 : Working capital¹⁹ / Total Assets ("WC/A"). It indicates how much the company holds in terms of net liquid assets relative to total assets. This ratio thus considers the size of the company and its liquidity, both direct and indirect.

x_2 : Retained earnings / Total Assets ("RET/A"). This ratio measures the firm's capacity for self-financing through the reinvestment of earnings. It also assesses the accumulated profitability over time, implicitly accounting for the company's longevity and for the use of external sources of capital²⁰.

x_3 : EBIT²¹/ Total Assets ("EBIT/A"). The ratio shows the real productivity or profitability of a company's assets since it is immune from the effects of leverage or taxation.

x_4 : Market Value Of Equity / Book value of debt²². The purpose of this ratio is to illustrate how much assets can decrease before liabilities exceed them and the company thus become insolvent.

x_5 : Sales / total assets. The ratio considers the degree of efficiency in asset utilization. It expresses the asset turnover rate, indicating the number of times invested capital is transformed into sales revenue during the year. Consequently, it measures the entrepreneurial ability of the company compared to firms within the same sector.

The initial version of Altman's model (1968) led him to conclude that a firm could be considered financially healthy if its Z-Score was above 2.99. Conversely, a score below 1.81 indicated a firm likely to fail, while scores in between these values fell into an area of ambiguity²³.

¹⁹ Working capital refers to the net amount obtained by subtracting current liabilities from current assets. Current assets comprise cash, and other assets that can be converted into cash within a year, such as inventories, cash and cash equivalents, marketable securities, accounts receivable, and prepaid expenses. On the other hand, current liabilities comprise debts or obligations due within a year, including accounts payable, notes payable, the current portions of long-term debt, and other accrued expenses.

²⁰ A high ratio suggests that the firm has predominantly financed its assets through retained earnings rather than relying heavily on debt or equity injections.

²¹ Earnings before interest and taxes.

²² The numerator value is given by the product of the number of shares issued by the company by the market value of a share. For the denominator, on the other hand, the book value is considered. Total debt includes both short-term and long-term debt.

²³ The model is constructed to forecast bankruptcy with precision up to two years preceding the actual insolvency, with its predictive accuracy declining sharply after this two-year period.

With regard to the model evolution, initially it was applicable exclusively to publicly held manufacturing companies. However, it was later adapted to include privately held firms as well, giving rise to the Z' model. The primary difference in this adaptation concerns the fourth independent variable x_4 (with market value of equity no longer available, the model uses the book value of equity instead). Furthermore, an additional variant of the model was developed to extend the analysis to non-manufacturing companies (Altman, Hartzell & Peck, 1998).

This variant, known as the Z'' model, can be outlined as follows:

$$Z''_i = 6,56 x_{1,i} + 3,26 x_{2,i} + 6,72 x_{3,i} + 1,05 x_{4,i}$$

In this case, there are four independent variables, and compared to the first version, the following differences can be observed:

- x_4 represents the ratio of the book value of equity to total liabilities ("E/L"), as for the Z'-Score.
- x_5 is no longer considered.
- The values of the parameters are different.
- Likelihood to fail is considered for Z'' scores lower than 1.1.

1.3.3. From Altman Z-Score to Probability of Default

The discriminant analysis is used to directly generate an estimate of the default probability associated with individual firms analysed. Indeed, it can be demonstrated that, if the independent variables follow a multivariate normal distribution, then the probability that a firm will default is given by:

$$PD = p(B | x_i) = \frac{1}{1 + \frac{1 - \pi_B}{\pi_B} e^{z_i - a}}$$

Where:

- $p(B|x_i)$ is the probability of belonging to group B (anomalous), given the vector of independent variables x_i .

- z_i represents the Z-score of the i-th firm.
- α represent the cut-off point;
- π_B indicates the a priori default probability, namely that default probability which does not depend on the individual firm but on sector or market values.

In conclusion, the analysis that will be conducted is based on comparing the Z-score of the same company at two different times. Therefore, with reference to the equation above, it is possible to compare the Z-score trends in two separate periods and draw conclusions about the increase or decrease in the probability of default.

2. Literature Review and Research Questions

While the previous chapter described the concepts that will be involved in the analysis, this chapter is dedicated to reviewing the literature concerning, on one hand, the dynamics underlying the use of debt in leverage buyouts, and on the other, the effects of these transactions on the performance of target companies. In doing so, it lays the groundwork for a proper contextualization of the research. Finally, the empirical questions guiding the study will be precisely formulated.

2.1. Literature Review

As highlighted earlier, it is well acknowledged that private equity investors, in conducting leverage buyout activities, employ a significant amount of debt (Kaplan and Strömberg, 2009). At the same time, the increase in leverage buyouts over the years and the use of debt in an ever-growing number of operations have raised concerns about the impact of this substantial debt on the default probability of the targets.

The examination of several academic studies suggests a dichotomy in opinions regarding the impact of leveraged buyouts on the probability of corporate default. While the results of some studies suggest that the entry of private equity investors could increase the risk of corporate insolvency, the analysis of other studies would lead to infer the opposite effect. More specifically:

1. On one hand, studies have highlighted the use of an amount of leverage larger than the optimal for the maximization of the firm value, with such financing being opportunistic and contingent on market conditions (Axelson et al., 2013). It is also argued that the greater the accessibility of debt, the greater is the propensity of investors to use leverage and overpay for target companies. Therefore, overpricing, combined with a large amount of debt to be repaid, could increase the target firm's probability of default, consequently reducing its Altman Z-Score. This represents a perspective that Hotchkiss, Smith and Strömberg (2021) describe as the “dark side”, considering it to imply a short-termism approach and an excessive risk-taking by investors in LBOs.

2. On the other hand, as previously mentioned, Jensen (1989) and subsequent researchers observe that the separation of ownership and managerial control generates a wide range of agency problems, such as ineffective internal supervision, managerial entrenchment, and operational inefficiency. This issue is mitigated in the case of leveraged buyouts, where there is greater managerial ownership, a disciplining role of debt, and an increased oversight and control. Indeed, the tighter alignment of interests between owners and managers leads to the implementation of restructuring activities (especially through debt) aimed at improving the company's growth and efficiency. Regarding performance outcomes, numerous academic papers during the years have analysed the effect of leverage buyouts on the performance, efficiency, and productivity of target companies (Amess, 2003; Harris et al., 2005; Lichtenberg & Siegel, 1990; Wilson, Wright, Siegel & Scholes, 2012), generally finding results that support Jensen's theory. Additionally, Haque and Sharjil (2023) highlight how private equity management leads to a considerable reduction in asset volatility. In conclusion, this “bright side” (Hotchkiss et al., 2021) view supports Jensen's theory and a long-term oriented approach of private equity investors. This would suggest a pragmatic impact of LBO on reducing the default risk, thus implying a potential improvement in Altman's Z Score.

Which of the two effects prevails is the crucial question this research aims to explore. However, to optimally contextualize the study that is conducted, it is essential to examine in greater detail the findings of the points previously mentioned.

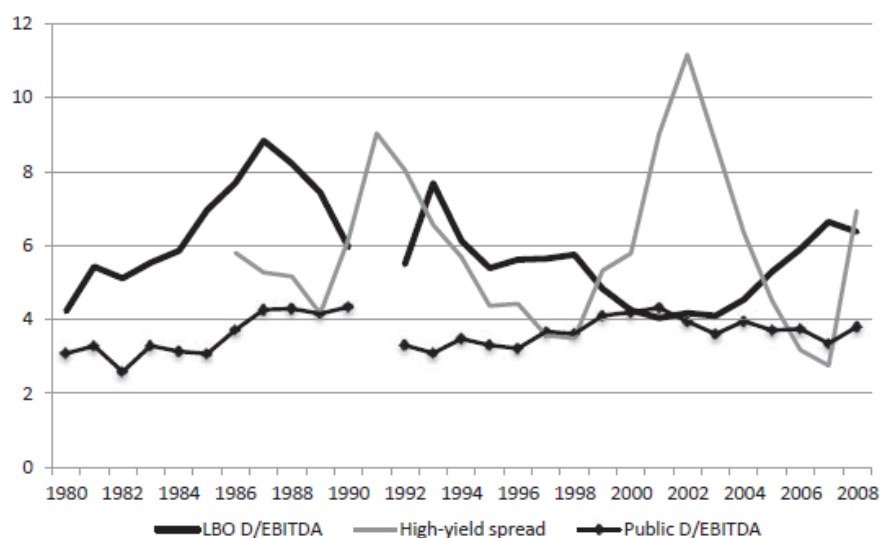
2.1.1. LBO and Altman Z-Score: Potential Negative Impact

The most crucial factor in an LBO transaction is the sponsor's ability to use debt as cheaply as possible. In this regard, starting from evidence of substantial use of debt, Axelson, et al. (2013) analyse whether the debt used in leverage buyouts is influenced by the same factors that affect comparable public companies. The study is based on the concept that the use of leverage can follow two different logics. On one hand, according to the debt trade-off theory (Myers, 2001), the deployment of debt occurs in a balance where the benefits derived from its use, such as tax advantages, are offset by the anticipated costs of bankruptcy. Thus, the use of debt should depend exclusively on the specific characteristics of the company, and therefore the dynamics of leverage in LBO targets and in similar public companies should be correlated. On the other

hand, the use of financial leverage in LBO could be influenced by constantly evolving market factors, driving private equity investors to adopt an opportunistic approach.

The results of their analysis do not show any relationship between the financial leverage of target companies and that of comparable public companies. If cross-sectional characteristics at the industry level have low explanatory power, what then could the use of such debt be attributed to? In the same study, it is shown that a robust predictor is represented by the conditions within the debt market. Figure 5 shows a strong relationship between the use of leverage in LBOs and market conditions, specifically analyzing the evolution of the Debt-to-EBITDA ratio in response to movements of high yield spreads. Sharp declines in leverage correspond to spikes in the high yield rate, such as those occurred during the collapse of the junk bond market in the late 1980s and the burst of the Internet bubble in the early 2000s. On the other hand, peaks in leverage are correlated with credit boom conditions, such as the one that ended in 2007. This correlation highlighted for the leverage of LBOs is absent for matched public companies. Axelson et al. (2013) also show that valuations in LBOs, measured with the EV/EBITDA ratio, also move with the high yield spread, following the same relationship outlined for leverage.

Figure 5. High Yield Spread and Financial Leverage: focus on LBO



Source: Axelson et al. (2013)

These findings can be interpreted through two main explanations presented by Hotchkiss et al. (2021). The first reason might be related to the structure of the compensation contracts. Specifically, the variable component of the GP's

compensation, namely the carried interest, works similar to a call option, giving the private equity fund managers an additional incentive to undertake riskier operations. This is because the potential for gain is unlimited while the risk of loss is capped²⁴. A second reason to consider concerns the structure of the private equity fund, whose limited life, around 10 to 12 years, might point to a short-term attitude of the fund managers. In this time frame, funds must make investments, divest, and distribute returns to their investors, possibly favoring short-term gains over long-term value in managing the targets. Therefore, through the financial leverage, sponsors could follow this short-term orientation in various ways, such as overpaying to acquire equity stakes due to the urgency to deploy capital, taking on excessive debt to avoid financial problems after unsuccessful projects, exploiting tax benefits, or recurring to dividend recapitalizations.

In conclusion, according to the "dark side" (Hotchkiss et al., 2021) perspective, the main factor influencing the amount of leverage used by private equity funds is the capital market rather than the amount the target actually needs, and this also leads to the overpayment of targets in negotiations. Therefore, whether it's due to the incentive structure of the GPs or a preference for short-term strategies, this approach subordinates the target company and especially its cash flows to servicing a higher level of debt than is fundamentally suitable, potentially increasing the risk of default.

2.1.2. LBO and Altman Z-Score: Potential Positive Impact

Although there are motivations for PE funds to use leverage above the optimal level for the target company, there are also various reasons to assume that such leverage leads to positive effects on the target company's business operations. As mentioned earlier, Jensen (1989) has argued that the PE ownership model, characterized by highly concentrated ownership, significant incentives for managers and employees, and high leverage, constitutes a significantly better corporate governance approach.

With regard to practical outcomes, over time researchers have evaluated the impacts of LBOs on target firms on a variety of accounting indicators. In this respect, some

²⁴ Similar to the way the value of a call option increases with the volatility of the underlying asset, the use of greater leverage could increase both the expected profits and the risk of the investment, while raising the value of the call option virtually held by the GP.

research works examine the positive impact of such transactions on growth (Scellato & Ughetto, 2013; Cohn, Hotchkiss & Towery, 2022) others on productivity and efficiency (Amess, 2003; Harris et al., 2005; Lichtenberg & Siegel, 1990; Wilson et al., 2012).

Firstly, the academic literature points out that after leverage buyouts there is an increase in both revenues and assets of targets, and thus private equity has a positive effect on investment and business growth in absolute terms. Scellato and Ughetto (2013), examining a sample of 241 buyouts involving European firms over the period 1997-2004, found that buyouts have a positive effect on the increase in total assets and employment of acquired firms, both in the short and medium term. Similarly, other studies confirm this evidence of business growth, e.g., Cohn et al. (2022) show consistent evidence of a significant and rapid increase in sales growth after the acquisition of private firms.

As for efficiency and productivity²⁵, a positive effect of buyout on both is observed. It corresponds to theoretical expectations that buyouts lead to more efficient use of firm resources and that improved supervision²⁶ stimulates firm-level performance and technical efficiency. Specifically, Lichtenberg and Siegel (1990) observed, 5 years after the LBO transaction, gains in total factor productivity (TFP²⁷) in plants in the U.S., attributing these improvements to organizational innovations rather than cost reductions. Shifting the analysis to the UK, Harris et al. (2005) found that factories involved in MBO, which were less productive than similar factories before the takeover, experienced significant productivity gains after the buyout. Other studies, such as those by Amess (2003), Wilson et al. (2012), exhibit the same results, highlighting the positive effect of LBOs over target companies' productivity compared to peers.

Regarding profitability, there are different views on the effect of LBOs on it. The evidence varies and is related to the type of indicator used. On one hand, some studies

²⁵ In the above cited studies, the specification used for the production function is based on the Cobb-Douglas model.

²⁶ As previously mentioned, supervision increases because of debt, increased incentive mechanism, and more active shareholder presence.

²⁷ Total factor productivity (TFP) is an indicator that represents a firm's productivity by establishing how much it produces in relation to how much it is required to spend to achieve that result. In simpler terms, it is calculated by dividing total output (output) by average costs (input).

use ROS²⁸, on the other hand ROA²⁹, and still others analyse ROIC³⁰. In general, as Guo et al. (2011) state, companies often revalue or write down the value of assets at the time of acquisition, making it difficult to identify a unanimous measure of profitability.

Finally, Haque and Sharjil (2023) find that average target's asset volatility decreases from 0.309 pre-acquisition to 0.177 post-acquisition. Lower asset volatility reduces the firm's time-weighted probability of default, and this benchmark result is consistent with the theory proposed by Malenko and Malenko (2015) that estimates that the incentives for a riskier management approach are lower under private equity ownership in an environment where debt contributes to the resolution of the agency problem.

In conclusion, the post LBO governance model described by Jensen, supported by the findings of the studies mentioned, suggests that the leveraged buyout transaction, with its improved organizational, corporate governance, and ownership structures, leads to a lower probability of default for the target companies.

2.2. Research Questions

After examining the evidence from the existing academic literature on the effects of leveraged buyouts on the performance and capital structure of target companies, this research aims to highlight the final impact on the Altman Z-Score and to break it down into the individual independent variables that compose it. Moreover, the study seeks to examine whether the presence or absence of an LBO, with its specific organizational structure and value creation levers, can be an additional factor to consider for future evolutions of the Altman Z-Score formula.

Following this logic, three research questions are addressed in this study.

²⁸ Return on sales (ROS) is obtained by dividing operating income by sales. It directly reflects the relationships between sales prices, volumes, and operating costs.

²⁹ Return on assets (ROA) is calculated by dividing net income by total assets, and it measures profitability in relation to all the resources employed by the company.

³⁰ Return on investments (ROIC) is derived from the ratio of net operating income after tax to invested capital. It expresses the company's capability to use capital for profitable investments within the operative sphere.

RQ1: Do LBOs have a significant impact on the default probability of acquired companies? If so, is it positive or negative?

This research question investigates the overall effect of leverage buyouts on the default probability of target companies by analyzing whether these transactions improve or worsen the Altman Z-Score of the firms.

RQ2: What is the effect of LBOs on individual components of the Altman Z-Score? Is this impact statistically significant?

The focus of this second question is to examine how each variable that composes the Altman Z-Score is affected by the LBO transaction, to understand in more detail the financial dynamics underlying the overall effect of the LBO on the score.

RQ3: What is the effect, if significant, of incorporating the LBO factor as an additional variable on the Altman Z-Score calculation model?

This third research question focuses on assessing, within the model built on Altman's Z-score formula, the effects of including variables that indicate the presence of LBOs.

2.3. Previous Findings and Research Gap

Before delving into the description of the methodology, model, and dataset used for research, it is essential to analyze how this study fits within the academic landscape, highlighting in what it resembles and, more importantly, how it differs from papers addressing the same subject³¹. This research is related, on one hand, to studies conducted on the effect of LBOs on default probability and, on the other hand, to papers investigating the impact of LBOs on the performance and financial indicators of target firms. Overall, the unique contribution of this research lies in the initially separate and then combined analysis of these two topics, with a specific focus on the Altman Z-Score.

³¹ The models and sample selections to which reference is made here will be precisely defined in the next chapter.

In terms of recent LBO waves³² and their effect on performance, many academic papers that examine this phenomenon have been previously mentioned to contextualize the research question. Notably, none of these studies explicitly focus on the analysis of all the variables that compose the Altman Z-Score. On the other side, in the context of studies addressing the impact of leveraged buyouts on the probability of default, there is a significant academic literature that employs hazard models and through the failure rate traces back the probability of default, mainly with binomial approach. These studies focus on analyzing the phenomenon at the European level (Wilson & Wright, 2013), in the US (Ayash & Rastad, 2021), and globally (Hotchkiss et al., 2021). Although the present research deals with the same topic, it differs in the model used and especially in the response variable analyzed, namely the Altman Z-Score³³.

Regarding the literature that jointly addresses LBOs and scoring models, Tykvová and Borell (2012) examine the impact of private equity ownership on the risk of financial distress, calculated using various indices, including the Altman Score. Comparing LBO targets in Europe during the 2000-2008 period with a control sample based on size, age, industry, and geography, their study finds that probability of default significantly increases between the year preceding the buyout and three years after. The present research differs from Tykvová and Borell (2012) in several aspects. In terms of the time horizon, this study extends beyond the period considered by Tykvová and Borell, analyzing the timeframe encompassing the two recent LBO cycles and the crises in between, allowing a multiplicity of systematic conditions to be incorporated into the analysis. Furthermore, this research adopts a difference-in-differences model to analyze the specific effects of LBOs. Finally, most distinctively, this research focuses also on the effect of LBOs on the individual components of the score, enabling a better understanding of which specific aspects of insolvency risk are most affected by LBO operations. Consequently, the study links the overall result on default probability to the strategic value creation dynamics of the private equity investor.

³² Regarding studies about the first wave of the 1980s, it is argued that the main cause of financial distress in leveraged buyouts is the high level of leverage. In this review section, the objective has been to consider studies that analyze the phenomenon over a more recent time horizon.

³³ Besides the geographical and empirical aspect, the studies also differ in the matching procedure used to determine the control group used in the analysis.

3. Data and Methodology

3.1. Sample Construction

Concerning the selection of the most appropriate method to examine the causal relationship at the heart of this research, this study adopts a statistical technique employed by previous works that have investigated the effect of LBOs on specific aspects of the targets (Bernstein, Lerner & Mezzanotti, 2017; Boucly, Sraer & Thesmar, 2011). In this regard, it has been chosen the difference-in-difference method, which compares firms involved in LBO transactions with a control group of companies that were not. As for the estimate of default probability, this study employs the Altman Z-score, since the use of such a score offers mainly two advantages:

- It allows to consider independent variables that have the same financial significance regardless of the industry or geography of the firms. Moreover, these variables, when considered one by one, can clearly explain a given business dynamic. In this way, it is possible, on the one hand, to contextualize the result to the entire population of companies and, on the other hand, to link value creation strategies to the changes in the independent variables considered in the score.
- It enables the examination of a limited number of variables that nevertheless manages to provide meaningful information. This results in an increased data availability and reliability.

Regarding the choice of the specific score, Z" Score (Altman et al., 1998) has been chosen in this research. According to Altman, Iwanicz-Drozowska, Laitinen, and Suvas (2014), the omission of the variable sensitive to sector-specific characteristics, i.e. the asset turnover, makes the Z"-Score a more versatile tool for financial analysis, as it enables its application across a broad spectrum of sectors³⁴.

In the following sections, it will be described firstly how the sample of target firms ("treatment group") and the sample of comparable firms ("control group") has been

³⁴ Companies in different sectors may tend to report different levels for the same financial ratio and this industry effect could be significant in the Z'-Score Model, particularly due to the Sales to Total Assets ratio (x_5). Indeed, it contributed significantly to the multivariate model's ability to distinguish between anomalous and healthy firms. Altman recognized the possible sectorial impact due to wide variations among industries in asset turnover and thus proposed the Z"-Score Model, excluding x_5 .

constructed, and then it will be discussed the empirical methodology, with a verification of the underlying hypotheses.

3.1.1. Treatment Group

One of the main challenges in private equity research is data availability. Since private companies are not publicly traded, they do not have the same disclosure requirements as publicly traded companies, particularly firms in the United States (except those that have issued public bonds). However, European companies are required to publicly present financial statements. In this study, therefore, the focus has been on LBO transactions targeting European companies, with no restrictions on the private equity investor's country of origin. Three different databases were used to identify LBO transactions, targets and comparables financial data: Zephyr, Orbis, and Capital IQ. It is important to note that from an initial sample retrieved on Zephyr, further selection was made by including only target companies for which financial data was available in the two years prior to and three years after the transaction. This is a pre and post buyout time horizon often used in the literature (Kaplan, 1989; Boucly et al., 2011)

Regarding the search for transaction data, from Zephyr there have been retrieved all transactions with the following simultaneous characteristics:

- i) *Type of transaction*: institutional buyout, managerial buyout.
- ii) *Type of sub-deal*: leveraged buyout.
- iii) *World region (Target)*: Western Europe.
- iv) *Time period*: completion date from 01/01/2003 to 01/01/2017. This time horizon was chosen with the intention to cover the performance effects of two distinct cycles of LBOs: the second (2003-2007) and the “third” (2012-2016). At the same time, the time frame was also chosen to investigate the impact of LBOs on firm performance during periods of economic uncertainty, particularly in 2008, while not considering the analysis of effects on targets in the Covid-19 period³⁵.

³⁵ Analyzing the effects while considering the Covid-19 impact should involve examining the situation one year prior the LBO and three years afterward. Since data for 2023 are not available, analyzing the performance outcomes at T+3 is not feasible. Therefore, for consistency, it has been decided to only

Along with the setting of these four filters, two other criteria were implicitly taken into account. First, in order to make the analysis as heterogeneous as possible, it has not been filtered by target current status. Thus, companies were selected regardless of being listed or unlisted, and regardless of their existing legal status. As pointed out by Sharjil and Haque (2023), an advantage of the Zephyr/Orbis platform over other databases is that it does not remove companies after a few years of inactivity, thereby minimizing the problem of selection bias arising from the fact that a substantial number of companies exit the market after facing financial difficulties. Therefore, regarding the legal and financial status of firms, in this research all the following cases were included: active firms, bankrupted, ceased, in liquidation, closed due to bankruptcy, in insolvency, in bankruptcy proceedings, subject to a rescue plan, and subject to a restructuring plan. Finally, secondary acquisitions were excluded because companies previously acquired by private equity investors may have higher debt levels than normal companies, which might affect the assessment of their default probability.

Once identified the deals, using the BvD identifier matching system, the following data on the targets were searched within Orbis: Two Digit NACE³⁶, Revenue, Asset, EBIT, Shareholders' Fund, Current Asset, Current Liabilities, Retained Earnings. In addition, for the data not available on Orbis, starting from the information about the date of completion of the transaction, through the Capital IQ software the same types of financial data have been retrieved.

As a result, this research studies a total of 92 transactions. The selected sample of transactions, as shown in Table 1, covers a time span characterized by different economic cycles. It ranges from periods of low interest rates (2003-2006) to phases with slightly higher rates (2006-2008), through periods of market dislocation and recovery (2009-2011), to low interest rates environments again (2011-2016). In this context, given the evidence that private equity funds' recourse to debt is sensitive to

consider the effects of buyouts up to the pandemic, thus until 2019. This rationale underpins the decision to stop at January 1, 2017.

³⁶ The NACE code, acronym for “Nomenclature statistique des Activités économiques dans la Communauté Européenne”, was developed in 1970 by Eurostat, the statistical arm of the European Commission. This classification scheme is employed to harmonize the categorization of economic and industrial activities within the countries of the European Union.

market conditions, it can be concluded that this research examines all possible responses of private equity funds to different macroeconomic situations.

Table 1. Distribution of the sample by period

Transaction Year	# of Deals	% of Deals
Post Dot.Com - Post Sovereign Debt Crisis ('03-'11)	17	18%
Post-QE ('12-'16)	75	82%

Source: own elaboration

Regarding the specific type of buyout, Table 2 shows that 70 percent of the analysed transactions are institutional buyouts, while 30 percent of the cases are managerial buyouts.

Table 2. Distribution of the sample by LBO Type

LBO Investor	# of Deals	% of Deals
Institutional Buyout	64	70%
Management Buyout	28	30%

Source: own elaboration

In addition, Table 3 refers to the non-financial characteristics of the targets. Geographically, in 39 percent of the cases the acquired firms are located in Great Britain, 29 percent in France, 15 percent in Italy, and the remaining 9 percent in the Netherlands, Spain, Germany, and Belgium. This is a geographical sample representation in line with the distribution registered in 2022, described in Chapter 1.

Table 3. Distribution of the sample by Geography

Target Geography	# of Deals	% of Deals
Belgium	3	3%
Germany	7	8%
Spain	4	4%
France	27	29%
United Kingdom	36	39%
Italy	14	15%
Netherlands	1	1%

Source: own elaboration

In terms of sectors considered, as can be seen from Table 4, the sample shows a uniform distribution across sectors.

Table 4. Distribution of the sample by GICS Sector

Sector	# of Deals	% of Deals
Materials	8	9%
Industrials	19	21%
Consumer Discretionary	23	25%
Consumer Staples	3	3%
Health Care	4	4%
Information Technology	8	9%
Utilities	8	9%
Real Estate	10	11%
Other	9	10%

Source: own elaboration

3.1.2. Control Group

As mentioned earlier, this study compares the effect of leveraged buyouts on targets through the comparison with another set of companies that did not go through such a transaction. Overall, besides the verification of the assumption of the difference-in-difference method that will be discussed later, the choice of selecting a set of comparable rather than adopting a randomization strategy follows a precise logic outlined by Tykvová and Borell (2011).

In the context of LBOs, randomization is not feasible for multiple reasons. First, the geographic and sectoral distribution of buyout investments is not random because equity investors are typically specialized investors who demonstrate a preference for certain sectors, as highlighted by Cressy, Munari and Malipiero (2007). Second, after selecting the country and sector in which to focus on, private equity investors conduct detailed analysis and due diligence to assess the strengths and risks of the investment, picking the appropriate target company with the specific required characteristics (Wilson, Amini & Wright, 2022). Therefore, the starting situation of the companies themselves may influence, to some extent, the probability of receiving PE investment. In order to consider these selection and self-selection effects, a precise matching procedure has been adopted. This matching technique is designed to control pre-

purchase characteristics and is a procedure whose result is the identification of control firms that are "similar" to the targets, but not involved in LBOs.

The main step of the process is then to identify a suitable "control group" for the set of companies involved in leveraged buyout transactions. In this control sample selection process, it has been followed the approach of Boucly et al. (2011). More precisely, for each firm in the treatment group, a "matched firm" or "control firm" is identified as the firm that meets the following three criteria:

- i) Belongs to the same 2-digit NACE sector.
- ii) Is headquartered in the same country.
- iii) In the year before the buyout, registered revenue and assets levels within a ± 35 percent range of those of the target. In the case of two or more matched firms for the same target, the one closest³⁷ to it was selected. Regarding the choice of the range, it is an average of the ranges used in the matching procedures of previously mentioned studies³⁸.

While the choice of criteria i) and ii) is connected to the concept of comparable and is rooted in the idea of a company operating in the same sector and market, the choice of iii) is key in the matching technique and leads to considering both income and asset aspects in the composition of the control group. In line with what was said earlier about the endogeneity of the acquisition event and given the characteristics of the methodology and its assumptions that will be described shortly, the choice of both variables follows a specific goal of matching two-by-two companies that would have performed similarly without the private equity involvement. Therefore, if the focus had been solely on one of the two variables, the outcome of the entire study could have not been the same. In other words, choosing a comparable company based solely on the revenue criterion or only on the asset criterion could lead to the selection of a different control sample.

More specifically, adopting a counterfactual approach, the comparison of a company from the treatment group with a defined control firm from the same sector and geographical area, with the same assets but widely different revenues could result in

³⁷ Distance is defined as the sum of the squares of the differences between the target and control company's assets and the target and control company's revenue.

³⁸ Boucly et al. (2011) use 50 percent, while Bernstein et al. (2017) use 20 percent.

matching companies with divergent business models. More critically for this research, such companies may engage in entirely different strategies in both the short and medium to long term. For instance, companies with different market shares could prioritize differently multiple activities, such as investments in marketing or R&D, market penetrations, geographic expansions, partnership establishments and M&A activities. Therefore, comparing revenues to assets, rather than assets alone, allows for the consideration of some key aspects of the company. In other words, if assets are the foundation on which the company can expand or withstand future financial challenges, revenues, being related to operating performance and business results, constitute one of the main factors to consider when planning future strategies in the medium to long term.

Conversely, in the case of two companies with identical revenues but completely different levels of assets, the capital structure's support to the strategies in the short and medium term is diametrically opposed. For example, for the same level of revenues, a company with significant assets might have a greater capacity to manage financial risks thanks to the presence of tangible resources that can be used as collateral for financing or as a store of value. On the other hand, companies with more limited assets may have to rely on other financial instruments, as they do not have the possibility to offer the same collaterals. Therefore, the access to financing is different, as well as the cost of debt, which impacts, all else being equal, profitability, liquidity, and, finally, the risk of insolvency. More generally, considering assets together with revenues, rather than revenues alone, allows for simultaneous consideration of the company's maturity state, long-term investment capabilities and financial stability.

In conclusion, the matching procedure based on both assets and revenues enables a more detailed comparison between companies that might otherwise differ significantly in terms of business trajectories in the medium to long term. Table 5 presents the results obtained through this mechanism, highlighting the mean and median of the variables considered in point iii). Looking at the data for the year prior to the leveraged buyout transaction ("T-1" or "Y-1"), it is shown that regarding revenues, both the treatment group and the control group have mean and median values that lie within a range of 10 percent. As for the assets, the treatment group has higher mean and

median values of 27 percent and 19 percent, respectively. Still, both values remain within a range of 30 percent.

Table 5. Summary statistics of Asset and Revenue in the Sample, T-1

<i>USD Thousands</i>	Treatment Group		Control Group	
	Mean	Median	Mean	Median
Asset	62628	28073	49166	23454
Revenue	69428	27656	65744	26570

Source: own elaboration

3.2. Research Methodology

In order to analyze the causal evidence of LBO transactions on the default probability, this study employs the Difference in Difference (“DiD”) methodology. The DiD estimation aims at identifying the effects of a specific intervention or treatment by comparing changes in outcomes variable over time between a group subjected to the intervention (the treatment group) and a group that was not (the control group). With this in mind, in this study an OLS model was defined as follows:

$$Y_{i,t} = \beta_0 + \beta_1 \times \text{Treatment}_i + \beta_2 \times \text{PostTreatment}_t + \beta_3 \times \text{DiffInDiff}_{i,t} + \epsilon_{i,t}$$

Where $Y_{i,t}$ is the dependent variable, measured for company i -th at time t . Treatment_i is a dummy variable that takes a value of 1 if the i -th company belongs to the treatment group, and 0 otherwise. Following the same logic, the variable PostTreatment_t takes the value of 0 if the outcome variable is recorded the year before the transaction, and 1 if the outcome variable is recorded three years after (“T+3” or “Y+3”). Lastly, the pivotal variable within the study is $\text{DiffInDiff}_{i,t}$ representing the difference-in-differences estimator, that takes the value 1 if the i -th company belongs to the treatment group and if the outcome variable is recorded in T+3.

As for the regression coefficients:

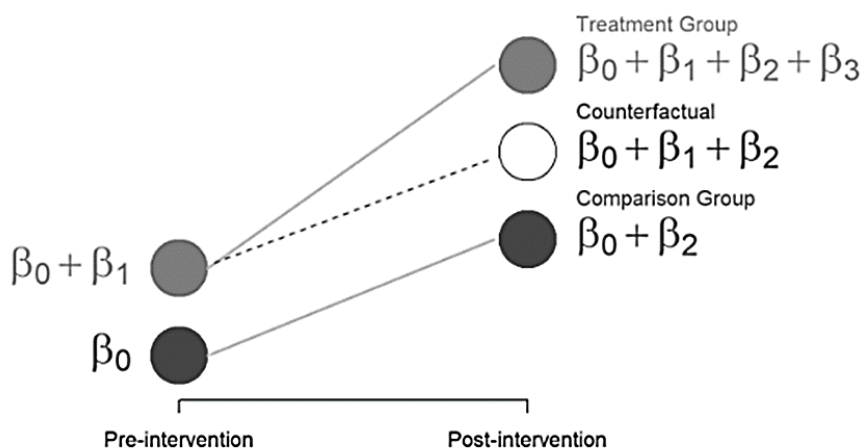
- β_0 represents the mean of the outcome variable for the control group, before the treatment.

- β_1 represents the difference in the averages of the response variable between the two groups, before the treatment.
- β_2 represents how the outcome variable has changed on average in the control group, after the intervention.
- β_3 represents the coefficient of interest in the DiD. It indicates how much, on average, the outcome variable of the treatment group has changed in the period after the treatment, compared to what would have happened without the treatment.

When taken individually, the parameters provide significant explanatory power, but their combination offers a further deeper insight. As Figure 6 shows, the interaction dynamics between them allows to understand more completely the evolution of the outcome variable in both the treatment and the control group.

- $\beta_0 + \beta_1$ represents the mean of the outcome variable for the treatment group, before the intervention.
- $\beta_0 + \beta_2$ represents the mean of the outcome variable for the control group, after the treatment.
- $\beta_0 + \beta_1 + \beta_2$ represents the so-called counterfactual, i.e., the mean of the response variable of the treatment group if the treatment had not occurred.
- $\beta_0 + \beta_1 + \beta_2 + \beta_3$ represents the average of the outcome variable, after the intervention, for the treatment group.

Figure 6. Difference in difference methodology



Source: Data Science for Public Service website

Before moving to the discussion of the research's results, it is crucial to validate the core hypothesis underpinning the difference in difference methodology, namely the parallel trends assumption. More precisely, since the causal interpretation hinges on the verification of the parallel trends' assumption, for the justification and discussion of the results it is fundamental to demonstrate that, in the absence of the leveraged buyout transaction, the companies acquired by the private equity investors would have exhibited the same trend evolution in the outcome variable as companies not involved in the LBO. This assumption is not directly testable through statistical methods, as the true counterfactual scenario without the intervention is unobservable. Therefore, a twofold analysis of the available data will be conducted.

Initially, the matching procedures for target and comparable samples reveals a baseline similarity between the control and treatment groups in terms of both revenues and assets. However, this similarity, while conceptually solid, is not in itself sufficient to test the parallel trend assumption, as it only captures the situation in the year prior to the transaction, not presenting any indication of trend.

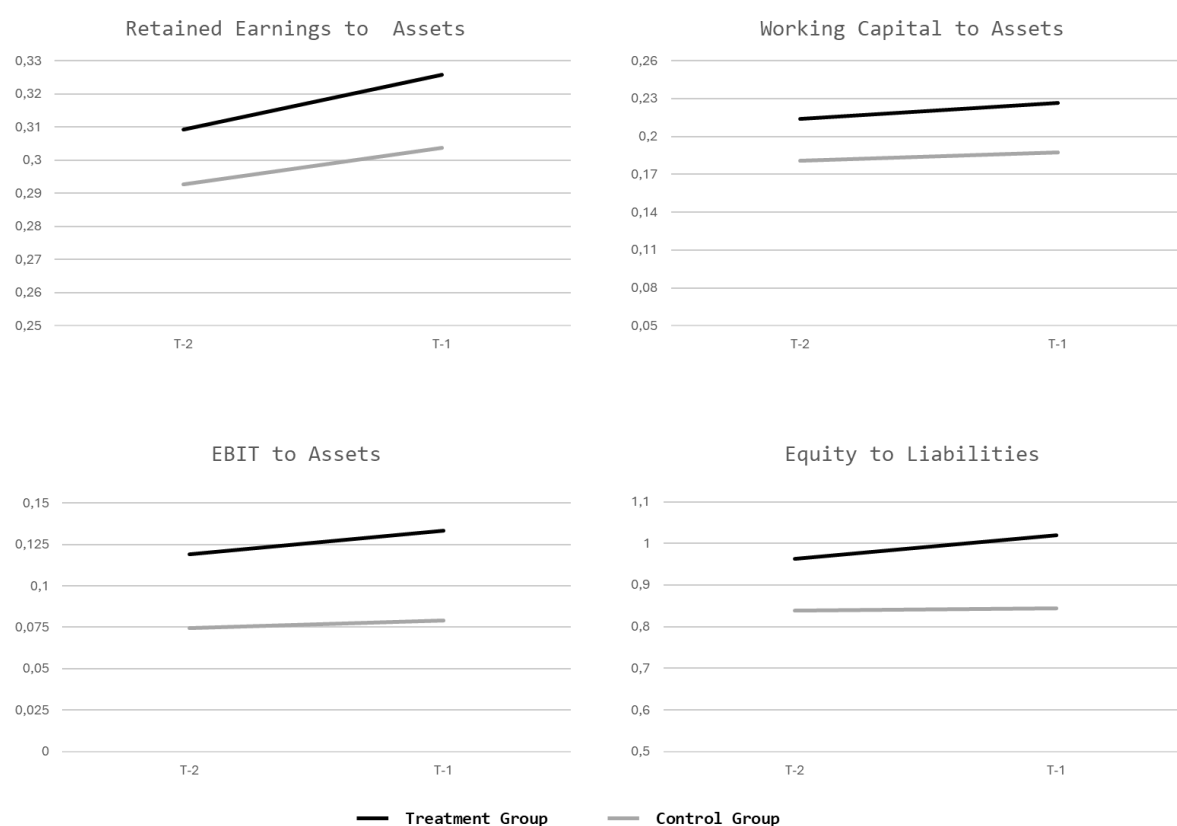
Therefore, it is important to specifically investigate the trend of the response variable before the intervention, highlighting similarities or dissimilarities between changes in the treatment and control group. Since the main outcome variable of the study is the Altman Z''-Score in its revised version (Altman et al., 1998), here the parallel trend hypothesis will be investigated by decomposing the investigation on each of its components, namely EBIT/A, RET/A, E/L, WC/A. In this way, in case of graphical verification of the parallel trend assumption for each of the variables, it will be possible not only to apply the difference-in-difference methodology to the Z-Score analysis, but also to each of its components. Therefore, it will be possible to lay the grounds for presenting evidence to all three research questions analyzed by the study.

As for the method used, following the approach outlined by Bernstein et al. (2017), it has been examined the trends of the individual components in the two years prior to the leveraged buyout transaction.

The four graphs in Figure 7 show the movement of the averages of the four variables in the years prior to the transaction. Graphically, the parallel trend hypothesis is met, with all variables on average moving approximately in parallel before the transaction,

and consequently it is also true for the corresponding Altman Z-Scores. Further observations on the distinct initial levels of these variables and their different trajectories post-LBO transaction will be discussed subsequently.

Figure 7. Trends of Av. RET/A, WC/A, EBIT/A and E/L in T-2 and T-1



Source: own elaboration

In conclusion, it is possible to confirm both conceptually (thanks to the matching selection) and graphically (through the analysis of the trends shown by the graphs in Figure 7) the verification of the fundamental hypothesis underlying the difference-in-differences method utilized in this research.

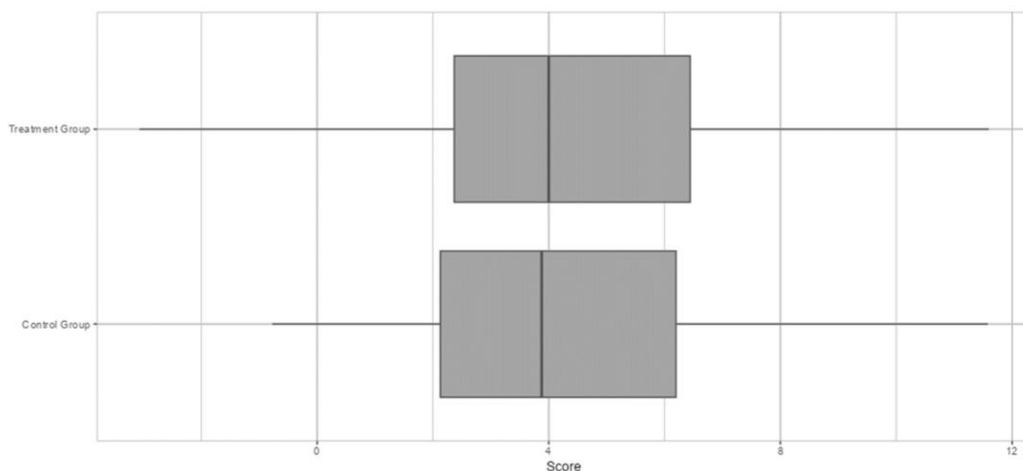
4. Research Results

4.1. Descriptive Overview

While the last section of the previous chapter focused on outlining variables' distribution in the years before the LBOs, this section shifts the attention to the general description of data. The purpose of this analysis is double. Firstly, it aims to show that the key variables are distributed in accordance with economic theory and with the evidence found in the literature. Secondly, this analysis aims to propose insights supporting the observations that will be outlined later. Therefore, attention will be paid to describing the key components of the parameters that act as response or control variables in the models that will be implemented.

Primarily, it is important to examine the Altman Z-Score distribution among the sample. This variable, as may be inferred from the research questions, will be at the heart of this analysis. In this regard, Figure 8 illustrates the difference in the Altman Z-Score between the target companies and their comparables. As can be seen, the box plots show a similar distribution of the variable measured the year before the transaction and three years after, for the two groups. More precisely, both the treatment and the control group exhibit roughly the same interquartile range, suggesting that the companies considered in the period under examination have not recorded excessively anomalous movements. Then, looking at the mean and median values of the Altman Z-Scores, the vast majority are above the threshold of 3, which is the boundary of the "grey zone" and the beginning of the green zone.

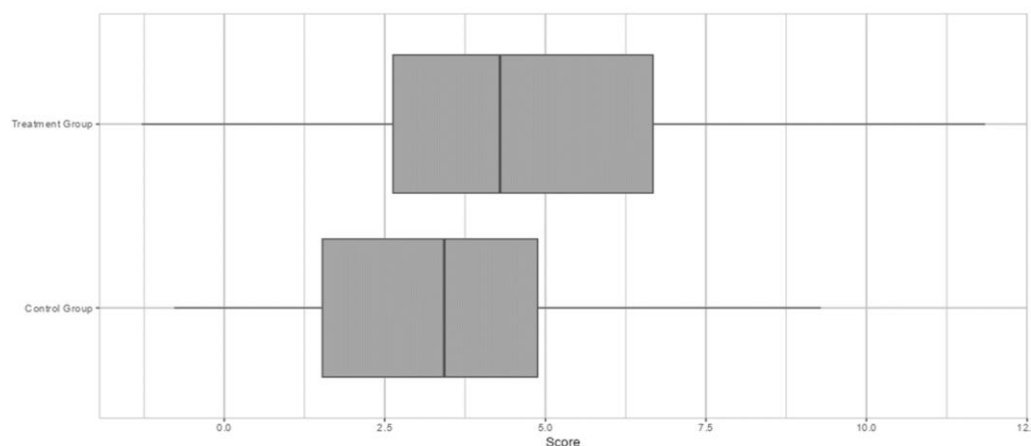
Figure 8. Box Plot of Altman Z-Score Distribution in the Sample



Source: own elaboration

Switching to the pre-buyout distribution of Altman Z-Scores of the treatment and the control groups, Figure 9 shows that, in the year prior to the transaction, target companies on average exhibited an Altman Z-Score that was 22% higher than the one of the comparables.

Figure 9: Box Plot of Altman Z-Score Distribution in the Sample, T-1



Source: own elaboration

In this regard, focusing on the year before the transaction, Table 6 revisits the mean and median for each variable, highlighting the differences in characteristics between the acquired firms and the comparables.

Table 6. Summary Statistics of Altman Z-Score components in the Sample, T-1

Data in Y-1	Treatment Group		Control Group	
	Mean	Median	Mean	Median
EBIT / Assets	0.13	0.11	0.08	0.06
Equity / Liabilities	1.02	0.72	0.84	0.55
Working Capital / Assets	0.23	0.26	0.19	0.14
Retained Earnings / Assets	0.33	0.34	0.31	0.26

Source: own elaboration

Notably, private equity investors tend to acquire companies that on average have a higher ratio of retained earnings to total assets, a bigger ratio of equity to total liabilities, a higher ratio of inventories to assets, and a greater profitability (EBIT/A). Therefore, from these findings it can be inferred that a higher pre-buyout Altman Z-Score among the targets can be justified, all else being equal, by strategic choices of private equity investors.

More precisely:

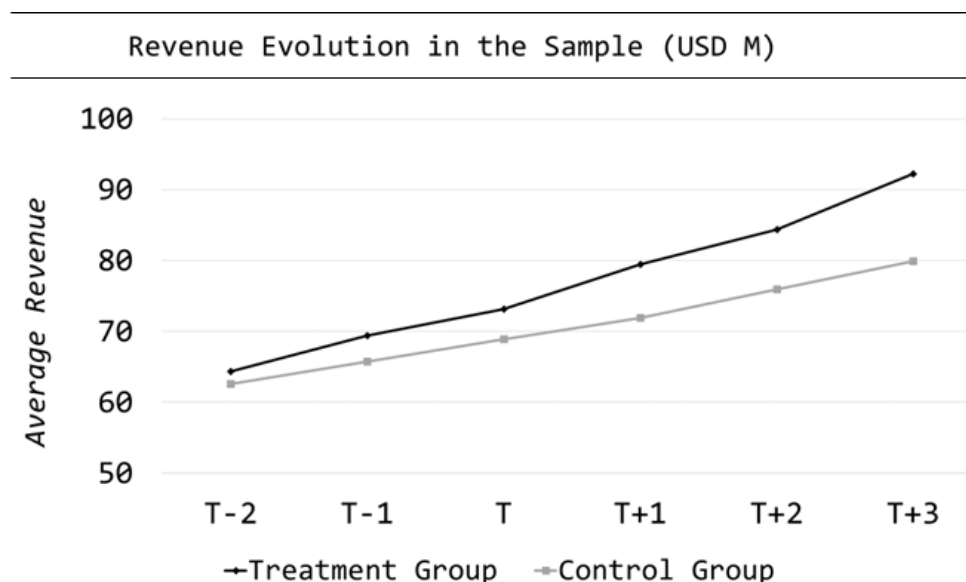
- The presence of inefficiencies in stock or generally in the working capital cycle represents an opportunity to improve inventory management, reduce costs, and enhance cash flow generation. It is consistent with the objective of creating value through operational levers, via the improvement of operating margins, and financial levers since the increasing cash flows available can serve debt repayments.
- Higher level of undistributed earnings serves as a capital buffer to protect future cash flows destined to debt reimbursements. This condition lays the groundwork for employing more debt in the transaction, thereby exploiting direct and indirect effects associated with financial leverage.
- Greater ratio of equity to liabilities, similar to the previous point, indicates on one hand financial and capital solidity, and on the other, a higher capacity to support the introduction of substantial debt.
- Higher level of profitability, in terms of EBIT/Assets, suggests a stable and healthy business. Potentially, even just by increasing the size of the firm, keeping the ratio constant, there's a possibility to create value through operational leverage. Additionally, a profitable company, all else being equal, benefits from a cheaper access to debt, thus representing an optimal target for transactions such as LBOs, which heavily rely on the use of debt.

Lastly, switching the focus on the distribution of revenues and assets, it is important to provide a more comprehensive overview of their trends since, although not shown in the outputs supporting the empirical results, they constitute the basis of the matching procedure, therefore playing a critical role in understanding the phenomenon under study.

Regarding revenues, empirical evidence, as previously mentioned, indicates a positive effect of leveraged buyout entry on revenue growth (Cohn et al., 2022). Figure 10 shows the revenue trends for both the target companies and the control group over a time horizon spanning from two years prior to the entry of the private equity investor to three years after. First, consistent with the literature, it can be observed that three years after the LBO, there is a significant increase in the revenues of the target companies compared to pre-entry levels. Moreover, a particularly important aspect to highlight is

that both groups experience an increase in revenues that is not widely different (Y-1 to Y+3 CAGR of 7.3 percent for the targets vs. 5.7 percent for the comparables); this evidence is crucial in the context of the research. Indeed, by comparing companies within the same sector, the fact that revenues increase in approximately the same way for both the treatment and control groups certifies that, on average, firms are subject to the same demand dynamics, albeit capturing them with different magnitudes. Therefore, in a context of similar corporate growth in terms of the classic price*quantity framework, any difference in movement of the Altman Z-Score would stem from operational choices. Thus, in this study managerial strategies emerge as the true differentiating factors, significantly influencing the productivity, efficiency, and overall financial health of the companies analyzed.

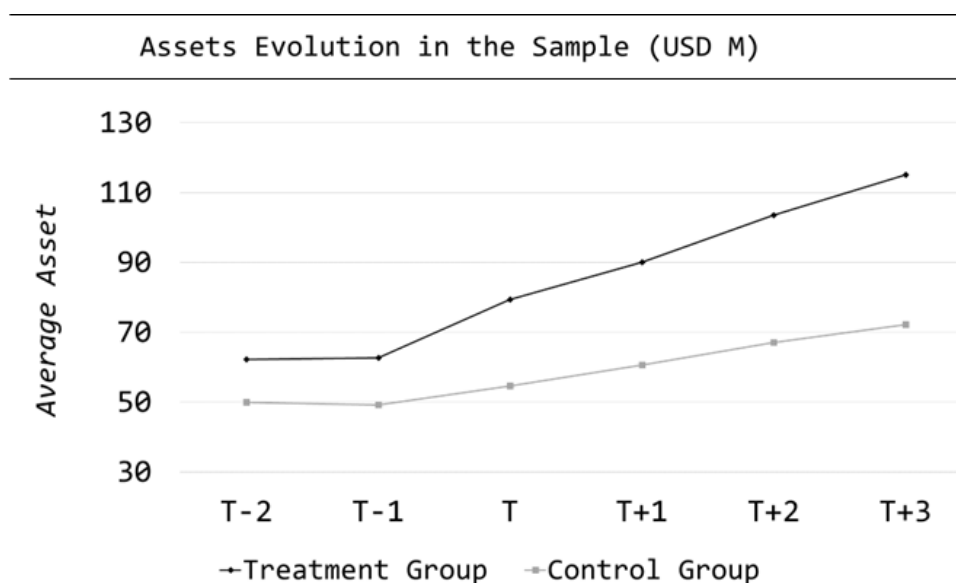
Figure 10. Evolution of Av. Revenue of Treatment and Control Group



Source: own elaboration

Following the same logic, Figure 11 shows the trends in average assets of both the treatment and the control group over the time horizon that goes from two years before the leveraged buyout transaction to three years after. Consistent with the studies previously referred to (Scellato & Ughetto, 2013), over the 4 years from Y-1 to Y+3, assets are increasing at a higher rate than their peers (16 percent CAGR versus 10 percent CAGR). This implies that such discrepancy in balance sheet size growth between the treatment and control groups should be taken into account when analyzing the empirical results.

Figure 11. Evolution of Av. Assets of Treatment and Control Group



Source: own elaboration

Hence, after delineating the distribution of main outcome variables and the matching covariates for both the treatment and the control group, the next step is to present the research findings.

4.2. Empirical Results

This section will present and discuss the empirical findings related to the research questions previously posed. Attention will be paid to both significant and not significant evidence regarding the impact of leveraged buyout transactions on the target's probability of default. Consistently with the research questions, the effect of LBOs on the Altman Z-Score will initially be analyzed, followed by a decomposition of the effect on each of the variables constituting it. Subsequently, the concepts behind the two outcomes will be integrated to address the third research question.

Before delving into the analysis, it is important to establish a general baseline for assessing the statistical significance of the results. This study will employ a significant level of 5 percent (0.05), and this criterion will be uniformly applied across all results that will be examined throughout the study, thereby ensuring consistency and rigor in the assessment of data significance.

4.2.1. Research Question n.1

RQ1: Do LBOs have a significant impact on the default probability of acquired companies? If so, is the effect positive or negative?

The results in Table 7 address the first research question. They are obtained from the difference-in-differences OLS regression based on data gathered through the procedure described above. The underlying formula for the model is as follows:

$$\text{Altman}_{i,t} = \beta_0 + \beta_1 \times \text{Treatment}_i + \beta_2 \times \text{PostTreatment}_t + \beta_3 \times \text{DiffInDiff}_{i,t} + \epsilon_{i,t}$$

In this case, the outcome variable $\text{Altman}_{i,t}$ refers to the Altman Z-Score of company i -th in the year prior to the LBO, or three years following the transaction.

Table 7. RQ1, LBOs effect on Altman Z-Score

Dependent variable:	
Altman Z-Score	
Intercept (B0)	3.60*** (0.41)
Treatment (B1)	0.81 (0.58)
Post-treatment (B2)	1.53*** (0.58)
Diff in Diff (B3)	-2.51*** (0.82)
Observations	368
R2	0.03
Adjusted R2	0.02
Residual Std. Error	3.94 (df = 364)
F Statistic	3.67** (df = 3; 364)
Note: *p<0.1; **p<0.05; ***p<0.01	

Source: own elaboration

Upon looking at the results, the estimate of the coefficient β_3 linked to the interaction term exhibits a p-value significantly below the 0.05 significance level. This statistical

significance indicates a substantial difference in the trajectory of the Altman Score between LBO target companies and comparable firms. The point estimate for this coefficient is -2.51, suggesting a negative impact of the LBO on the Altman Score of target companies after three years, relative to what happens to comparable firms. Moving on to the evaluation of the model, the p-value for the overall F-test³⁹ is lower than 0.05. Firstly, this implies that the R-squared value of the model is significantly different from zero, secondly it indicates that some of the variables included in the model significantly contribute to explaining part of the variation in the Altman Score of the companies analyzed⁴⁰.

This result is aligned with various studies examining the impact of LBOs on the probability of default. Notably, beyond being consistent with the findings of Tykvová and Borell (2012), such outcome of a negative effect on the probability of default, despite not being measured with the Z-Score or via difference-in-differences method, is similarly reflected in the study of Ayash and Rastad (2021). They measure the effect of the buyout on probability of bankruptcy for an LBO group consisting of public to private transactions with an arguably acceptable counterfactual control group made up solely of publicly listed companies. Using a probit model, they find that these transactions increase the probability of bankruptcy for the target firm by approximately 18 percent.

While the overall effect on the decrease of the Altman Z-Score will be disaggregated and examined in detail later on, each of the point estimates within the regression merits attention, as collectively they highlight some of the underlying dynamics of private equity value creation strategies.

Regarding the coefficients estimates, the discussion on coefficients β_0 and β_1 was addressed in the previous descriptive review, therefore this section focuses on coefficients β_2 and β_3 . Specifically, the OLS regression results highlight a convergence

³⁹ The F-test evaluates whether the model's predictors, as a group, are jointly significant. A high F statistic suggests that the model provides a significant improvement in fit over a model with no predictors.

⁴⁰ As can be observed, the R-squared is 0.03, and although statistically significant in this context, it indicates that only 2 percent of the variance of the dependent variable is explained by the independent variables in the model. However, it is important to contextualize this result within the framework of the difference-in-differences methodology, whose primary objective is to estimate a causal effect rather than to fully explain the variance in the dependent variable.

in the average Altman Z-Scores of the target firms and their comparables. Initially, from a baseline score of approximately 4.5, target companies on average registered a decline slightly above 3.5. Conversely, comparables, starting from an initial mean score of 3.6, reach a score close to the targets' initial score of 4.5. This pattern of convergence is in line with findings of Tykvová and Borell (2012).

These results should be contextualized within a broader view related to the consequences of an Altman Z-Score decrease. Although the study's outcome indicate that LBOs negatively impact the Altman Z-Score, this does not necessarily imply a significant effect on the bankruptcy event, given the difference between the probability of failing and the actual failure. Moreover, economic theory links increased default probability to worsening credit merit and hence to pricier financing access. However, other considerations, such as the dynamics between banks and sponsors must also be taken into account. Therefore, as for the latter point, looking at the academic literature, Ivashina and Kovner (2011) stated that the bank relationships, built through repeated interactions, mitigate information asymmetry inefficiencies, facilitating favourable loan terms for firms backed by private equity investors. Additionally, concerning the bankruptcy event, Tykvová and Borell (2012) find no evidence that private equity investors lead their companies into greater financial difficulties culminating in bankruptcy. Lastly, Hotchkiss et al. (2021) further elucidates that PE-backed companies in financial distress are more prone to restructuring outside of court, achieving quicker resolutions and a higher probability of remaining viable, independent entities compared to their distressed comparables without PE support⁴¹.

Overall, in discussing the results addressing the first research question, it is important to highlight that, on one hand, this negative effect on the Altman Z-Score could be perceived as evidence of opportunistic behavior of the investor, in line with the "dark side" perspective mentioned by Hotchkiss et al. (2021). On the other hand, it can be argued that Altman's Z-Score, particularly its variant Z", may not fully capture certain aspects of the operational value creation strategy. Specifically, normalizing only by assets and not considering also revenue, the measure of profitability (x_1) does not fully

⁴¹ More favorable outcomes in times of financial distress are attributed to two key factors. Firstly, the financial capability of PE owners to inject capital into their companies using the resources accumulated and unutilized by the fund (dry powder) can be utilized to support portfolio companies in distress, infusing new capital and facilitating agreements with creditors. Secondly, reputation effects incentivize private equity to avoid default, or at least to minimize the costs to lenders in the event of default.

account for the precise objective of scaling the business, thereby not allowing for a comprehensive analysis of management strategy. In conclusion, while the evidence of an incremental effect on default probability remains solid, it is not possible to extend the result to either short or long-term private equity investor orientation.

4.2.2. Research Question n.2

RQ2: What is the effect of LBOs on individual components of the Altman Z-Score, and is this impact statistically significant?

Once the general effect of private equity on the Altman Z-Score of the target companies has been analyzed, it is important to breakdown this impact on the individual variables that compose the score, namely, x_1 (WC/A), x_2 (RET/A), x_3 (EBIT/A), and x_4 (E/L).

In this regard, Table 8 presents the results of four difference-in-difference OLS regressions structured exactly as defined in the model previously described:

$$Y_{it} = \beta_0 + \beta_1 \times \text{Treatment}_i + \beta_2 \times \text{PostTreatment}_t + \beta_3 \times \text{DiffInDiff}_{i,t} + \epsilon_{i,t}$$

The only parameter that changes is the outcome variable, taking the value of one of the 4 constituents of the Altman Z-Score for each of the 4 OLS regressions.

Table 8. RQ2, LBOs effect on Altman Z-Score components

	EBIT/A	E/L	WC/A	RET/A
Intercept (B0)	0.08 *** (0.01)	0.84 *** (0.12)	0.19 *** (0.03)	0.31 *** (0.03)
Treatment (B1)	0.05 *** (0.02)	0.18 (0.17)	0.04 (0.04)	0.02 (0.05)
Post-treatment (B2)	0.00 (0.02)	0.51 *** (0.17)	0.10 ** (0.04)	0.08 * (0.05)
Diff in Diff (B3)	-0.03 (0.02)	-0.58 ** (0.23)	-0.15 ** (0.06)	-0.16 ** (0.07)
N.obs	368	368	368	368
R Squared	0.04	0.03	0.02	0.02

*** p < 0.01; ** p < 0.05; * p < 0.1.

Source: own elaboration

In the previous section, the descriptive analysis indirectly addressed the interaction of β_0 and β_1 , emphasizing differences in averages between the control group and the treatment group for each variable in the year before the buyout operation. Therefore, in line with the rationale used to present the evidence to the first research question, this section will focus on the analysis of the β_2 and β_3 coefficients, which as mentioned earlier allow to examine the evolution of the outcome variable 3 years after the levered buyout event.

Starting with the first column, since the β_3 parameter estimate has a p-value above the previously established threshold, the research results indicate that the impact of the leveraged buyout on the EBIT/Asset ratio is not statistically significant. The lack of statistical significance precludes any discussion of this effect and, as mentioned earlier, is substantially in line with the literature that, for decades, has held different viewpoints on the effect of leveraged buyouts on profitability, both in terms of Net Income to Asset and EBIT to Asset, depending on the sample, geography or type of transactions considered and the matching mechanism used to identify an appropriate control group.

Regarding the second column, in the context of this research it represents a key point since it reflects the effect of LBOs on the equity to liabilities ratio, and, if found to be significant, highlights what has been the impact of the private equity investor's strategy on the company's ratio three years after the transaction, considering the substantial amount of debt introduced. As evidenced by the point estimate of the coefficient β_3 , which is statistically significant (p-value lower than 0.05), the LBO transaction has a negative impact on the equity-to-liabilities ratio. Consequently, if the effects of secondary value creation mechanisms are not considered, it can be argued that the use of financial leverage in LBOs directly contributes to increasing the probability of insolvency of target companies, given the robust impact on the leverage ratio. This economic rationale finds support in the research by Singh (1990), who argue that, all being equal, financial debt enhances the susceptibility of the companies to external shocks, such as rising interest rates, thus increasing their likelihood of default.

However, this negative effect should be analyzed in an absolute perspective, focusing not only on β_3 but also on β_2 , thus accounting for the overall movement of the sole target's leverage ratio. More precisely, observing the regression coefficients, the final

effect on the target's ratio is given by summing the estimates of β_2 and β_3 , which are both significant. This sum indicates that the ratio for the targets on average has decreased, but only slightly below the pre-buyout level (an increase of 6.5 percent over four years). This result, given the leveraged buyout's high reliance on financing, may suggest that a significant recapitalization process occurred, either through capital injections or through a significant debt repayment process. Overall, the re-establishment of the equity to liabilities conditions similar to those prevailing before the leveraged buyout suggests that in the sample analyzed there is evidence of strong implementation of financial engineering by the private equity investor in the overall value creation strategy.

As for the third column, with a p-value lower than 0.05 for the estimate of the coefficient β_3 , the results suggest that there is a significant and negative effect of LBOs on the ratio between working capital and assets. More specifically, in absolute terms, the ratio in the targets sample significantly decreases by 0.05. This decrease, compared to an initial level of around 0.23, constitutes a significant 22 percent difference. The result is consistent with the findings of Easterwood et al. (1989), who showed a high incidence of LBOs on tightening working capital through the reduction of creditor days and, to a slightly lesser extent, through a more rigorous control of inventory. In general, this is a result associated with an improved resource management, achieved by rationalizing inefficiencies and managing trade receivables, inventory, and trade payables.

At first glance, it may seem peculiar that the concept of efficiency improvement is inversely related to the concept of the probability of default. Therefore, it is important to explain the dynamics underlying working capital from both a value creation perspective, following the private equity owners underlying strategy, and a default probability perspective, in line with Altman Z-Score assessment's logic. On one side, private equity investors often seek to optimize working capital management by increasing current liabilities or enhancing the efficiency of current assets (trade receivables and inventory), thereby influencing the ratio between working capital and total assets. This strategy leads to a reduction on costs and on current investment needs, resulting in smaller positive changes in working capital for the same business growth, which positively impact the company's ability to generate cash to meet other longer-term investment needs, or to repay debt. On the other side, the working capital

item is related to the concept of a company's short-term liquidity. Therefore, from the Altman model perspective, given the same level of assets, a reduction in working capital could pose challenges for a company in addressing short-term issues, such as supply chain and demand shocks.

In conclusion, regarding the effects of leveraged buyouts on the working capital to assets ratio, the research's findings are aligned to the concept of LBOs' enhancement of operational efficiency, with the investors aiming to create value by de-leveraging and improving margins. Hence, with regards to LBOs effects, the study emphasizes the resource optimization theory prevailing in existing literature, while highlighting the potential negative effect associated with adopting a more aggressive and hazardous management of a company, as reflected by its contribution to the overall impact on Altman Z-Score.

Finally, concerning the fourth column, the significance and negative sign of the estimates of β_3 suggest that leveraged buyouts have a negative impact on the self-financing ratio. Since the ratio between retained earnings and assets is essentially a measure of how dependent the company is on external sources of capital, the result suggests that three years after the leveraged buyout, target companies are less capable of self-financing and rely more on external sources of capital, such as equity or debt. In other words, resources dedicated to self-financing do not grow proportionally to assets. Considering the previous observation about the non-statistically different operating profitability between the treatment and the control group, besides the denominator effect, what primarily might explain the differential trend of this variable is that profits may be used to service the debt incurred during the leveraged buyout, or to remunerate shareholders. Thus, rather than being reinvested, cash flows are allocated to interests and principal debt payments or to dividends, in part supporting the value creation strategy associated with financial engineering mechanism.

In conclusion, the results presented in this section provide a breakdown of the general effect of LBOs on targets' default risk, examining each component of the Altman score individually. The analysis shows that private equity's negative and significant effect on default risk is mainly related to its objective of optimizing cash flows and capital

position, in line with the strategy of creating value through the financial engineering lever.

4.2.3. Research Question n.3

RQ3: What is the effect, if significant, of incorporating the LBO factor as an additional variable on the Altman Z-Score calculation model?

After discussing on the effects of LBOs on the Altman Z-Score both overall and on its individual components, this section aims to determine whether, given the classic model built on the variables involved in the Altman Score equation, the addition of the difference in difference regression variables offers a more comprehensive interpretation of the Altman Score. To this extend, the difference in difference OLS model (“extended model”) is built as follows:

$$Y_{it} = \beta_0 + \beta_1 \times \text{Treatment}_i + \beta_2 \times \text{PostTreatment}_t + \beta_3 \times \text{DiffInDiff}_{i,t} + \beta_4 \times X_{1,i,t} + \beta_5 \times X_{2,i,t} + \beta_6 \times X_{3,i,t} + \beta_7 \times X_{4,i,t} + \epsilon_{i,t}$$

Pragmatically, to the independent regressors associated with the traditional calculation formula of the Altman Score, variables accounting for the impact of LBOs, following the DiD logic, are added. Therefore, the regressor $X_{1,i,t}$ represents the EBIT/A registered for the company i -th, either the year before the LBO, or three year after, and the other regressors (X_2, X_3 and X_4) follow the same logic. From another point of view, the regression model defined above can also be constructed from the standard model used for research questions 1 and 2, with the addition of the components of Altman's Z-Score as control variables.

Focusing on the regression output, as can be seen from Table 9, the effect of the LBO is significant (the p-value of the β_3 estimate is lower than 0.05) and negative. Therefore, the impact of these transactions is still considerable, also with Altman Z-Score's components as control variables.

Table 9. RQ3, LBOs effect on Altman Z-Score, Extended Model

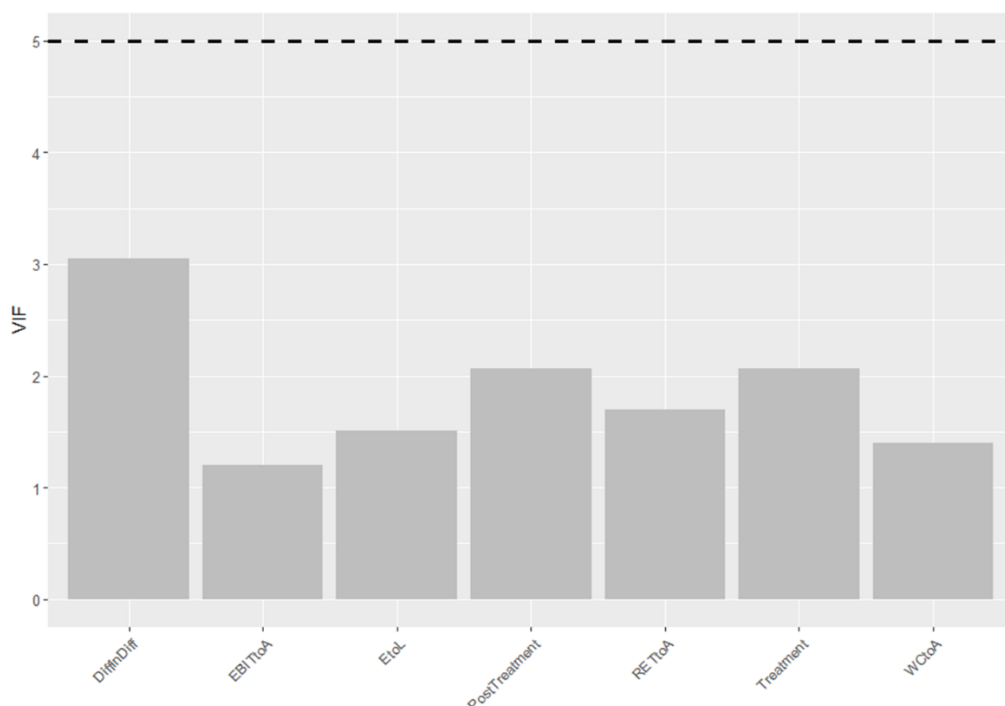
Dependent variable:	
Altman Z-Score	
Intercept (B0)	-0.16 (0.15)
Treatment (B1)	-0.002 (0.18)
Post-treatment (B2)	0.004 (0.18)
Diff in Diff (B3)	-0.55** (0.26)
E/L	1.12*** (0.07)
WC/A	6.06*** (0.26)
EBIT/A	5.68*** (0.63)
RET/A	4.02*** (0.25)
Note: *p<0.1; **p<0.05; ***p<0.01	

Source: own elaboration

Before drawing conclusions that the "extended model" specification offers different coefficient estimations of the score's components along with a negative and significant effect of LBOs on the Altman Z-score, it is crucial to conduct a test on one key aspect, namely the multicollinearity. In other words, to ensure the reliability of the estimates obtained through the regression based on the extended model, the absence of multicollinearity should be checked. Multicollinearity occurs when two or more independent variables in a regression model are highly correlated with each other, and this phenomenon complicates the distinction of the specific effect of each variable. There are various ways to detect multicollinearity in an OLS regression. The variance inflation factor ("VIF") has been used in this study. More specifically, the VIF identifies the correlation, and the strength of that correlation, between the independent variables; it starts at 1 and have no upper limit. VIFs above 5 represent critical levels of multicollinearity indicating that coefficients are inaccurately estimated, and p-values

are unreliable. As can be seen from Figure 12, there is no warning sign regarding the presence of multicollinearity, as none of the regressors show a value above 5.

Figure 12. Variance Inflation Factors for Independent Variables, Extended Model



Source: own elaboration

In conclusion, since the test show consistent results, it is possible to proceed with the interpretation of the evidence related to the third research question.

The findings reveal that by incorporating variables accounting for LBOs into the model built on the original formula, alongside different coefficient estimates, there is still evidence of a significant impact on Altman Z-Score. Therefore, given the precise governance structure of LBOs, their specific value creation objectives, and the particular role of debt, the results suggest the possibility of recalibrating the traditional coefficients of the Altman Z-Score to reflect the specificities of the effects of these transactions. Indeed, as previously described, Altman Z-Score formula has undergone several evolutions over the years, progressively proposing new models and calculation methodologies that have extended its applicability from solely US-listed manufacturing companies to global private and non-manufacturing enterprises. In this regard, the results of this study could provide insights for further research aimed at a possible re-evaluation of the Altman Z-Score formula, this time considering whether the company has undergone an LBO or not.

5. Final Considerations

Conclusive Remarks

The research questions of this study arise from the evidence of the academic literature on LBOs, which highlights both the risks associated with overleverage and opportunistic use of debt, and the positive effects of these transaction on efficiency, productivity, and growth. Consequently, this study aims to analyze the prevailing effect in terms of default probability of the target company.

The empirical investigation is based on the study of a sample of 92 LBOs targeting European companies. The research applies the difference in differences methodology, implemented through an OLS model that compares the data of the target companies and their respective comparables, one year before the transaction and three years afterward. The control sample's selection followed precise matching criteria and included a preliminary check of the parallel trend assumption for each of the four variables that constitute the Altman Z-score.

Regarding the results, the study first demonstrates that LBOs have a negative effect on Altman Z-Score of the targets, thereby increasing their probability of default. It also shows that private equity funds acquire companies with a higher initial Altman score. This is indicative, on one hand of a balance sheet and earnings situation that can support the injection of a significant amount of debt, and, on the other hand, of the presence of certain inefficiencies, such as high working capital levels, that can be solved to create value both operationally, by improving margins, and financially, by increasing cash flows. Regarding the overall result, while the negative impact on the score might suggest that both the cost of borrowing and the failure rate increase, it should be kept in mind that there is extensive evidence in the literature about private equity funds establishing more frequent interactions with banks, with a consequent reduction in information asymmetries, and thus an access to preferential debt terms. Additionally, studies demonstrate that private equity funds are more successful in avoiding situations of financial distress, in part due to the ability to inject money thanks to their dry powder.

Subsequently, the research identifies which variables are most impacted by the transaction, linking the variation of the Altman score with the dynamics behind value creation objectives in LBOs. There is no empirical evidence on profitability, but the other three variables are influenced in the same direction. Indeed, the results highlight that the equity to liabilities, liquidity ratio, and self-financing ratio are negatively impacted by the entry of private equity investor through LBO. As previously mentioned, entering companies with a higher Altman score, and thus initially high working capital on assets, high retained earnings on assets, and high equity to total liabilities, allows the private equity investor to mainly benefit from the financial engineering lever to create value, by exploiting the business's ability to repay the debt.

Lastly, the research focuses on a re-proposition of the Z-Score that accounts for the LBO component on its formulation. Taking the Z-Score as outcome variable, the study introduces an extended model that, starting from the original linear model built on the four classic independent variables of the Altman Z-Score, includes the additional dummy variables of the difference-in-differences methodology. The results show that the effect of LBO remains significant and negative, even when accounting for Z-Score components as control variables. Therefore, after testing for the absence of multicollinearity through the variance inflation factor, this finding is intended to set the stage for future research on potential evolution of the Z-Score formula, that might consider the impact of LBOs and, consequently, the particular role that debt, governance system and value creation objectives play in this type of transaction.

Limitations and Suggestions for Future Research

The research's results refer to a specific timeframe of analysis, notably a three-year period following the acquisition. This time horizon is frequently considered in literature when assessing the impact of leveraged buyouts. However, it is important to note that the average holding period for LBOs in Europe is approximately 4.6 years (Jenkinson, Morkoetter, Schori & Wetzer, 2022). This discrepancy suggests that the evidence found may only partially reflect the value creation strategies of private equity firms.

In other words, extending the comparison period could potentially yield different conclusions. In acquiring a target, private equity investors typically aim to improve governance structures and operational efficiency, and this process involves incurring

costs that have an immediate negative effect, with the expectation that operational benefits will emerge over time. Therefore, although the three-year analysis timeframe generally captures the so-called inflection point⁴², it risks overlooking the full realization phase of the investment. This perspective suggests that a more comprehensive evaluation of private equity strategies requires a broader timeframe, which accurately reflects the average holding period and allows for a more complete assessment of the investment's lifecycle, from initial changes to the realization phase.

In terms of space for future studies, in addition to redefining aspects of Altman's Z-Score formula, this research can be a starting point for further analysis on the impact of private equity on default risk, with a shifting focus towards the private equity investors. More specifically, starting from the evidence that the involvement of private equity investor tends to deteriorate the Altman Z-Score of the acquired company, it would be interesting to examine two specific phenomena related from one side to the transaction and from the other side to the investor. For example, new studies could delve into the differences in impact on default risk by considering i) syndication⁴³ and ii) experience of the private equity firm.

- i) With regard to syndication, it could be analyzed the difference in the impact on default risk between transactions involving syndication and transactions not involving it. Syndication of investors can have various effects on default risk. On one side, a significantly larger and aggregated network of investors could allow access to more accurate information, enabling better selection and reducing the risk of failure. Moreover, the combination of diverse skills among acquirers could result in more intensive monitoring and superior quality support. On the other side, potential negative effects are related to the complexity in decision-making processes that could slow down the implementation of new strategies or the response to both idiosyncratic and systemic difficulties.
- ii) The experience of private equity investors influences the selection of buyout targets and their post-acquisition development, with potential effects on

⁴² In this case, an inflection point is defined as the point in time when value begins to be created considerably relative to the upfront costs incurred.

⁴³ Syndication refers to the situation where more than one buyer participates in the investment.

default risk. More specifically, inexperienced acquirers might tend to invest in riskier companies to achieve standout successes, adopting more aggressive strategies with a higher risk of failure. Conversely, experienced investors, protecting their reputational capital and having greater selection and enhancement abilities, tend to pursue more conservative strategies. On the other hand, it could be argued that experienced investors, due to their stronger relationships with banks and better negotiation capabilities, might obtain larger amounts of debt compared to inexperienced funds, thereby potentially increasing the risk in the targets.

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Introduction

In recent decades, academic literature has extensively examined the phenomenon of leveraged buyouts (LBOs), exploring every aspect of these complex transactions. From investment processes to the various stakeholders involved, and from methodologies for value creation to investment objectives in terms of risk and return. Significant attention has also been dedicated to the operational effects on target companies, with studies focusing on management buyouts (MBOs) (Kaplan, 1989; Bédu, N., & Palard, J. E., 2021) and on institutional buyouts (IBOs) (Meles, A., Monferrà, S., & Verdoliva, V., 2014).

This thesis proposes a comparative analysis of the operationing performance of target companies, comparing the two main types of LBOs mentioned earlier, i.e. IBOs and MBOs, focusing on the Altman Z-Score and thus their impact on the risk of default. To achieve this objective, the study will be built on the work of Romaniello, Dallochio, and Rodemeier (2024), using the same sample of companies and conducting a descriptive analysis of the various factors that influence the impact on the Z-Score, always focusing on a comparative approach between MBOs and IBOs.

Therefore, the objective of this study is to investigate differences in the effects on target companies, a topic that is widely addressed in the existing literature but deserves detailed analysis given the increasing importance of private equity in allocations not only by institutional investors but also, thanks to ELTIF regulation, by retail investors.

The structure of this study is as follows:

- Chapter 1: introduction of the fundamental definitions of management buyouts and institutional buyouts, with particular attention to the peculiar characteristics of the two types. It also reviews the concept of the Altman Z-Score and its relevance in measuring the default risk of companies.
- Chapter 2: exploration of the academic literature analyzing the differences between the two types of transactions, alongside a discussion on the potential differentiating factors between management buyouts and institutional buyouts at the operating level of the target company.
- Chapter 3: details on the data collection process.

- Chapter 4: presentation of the results through a descriptive analysis, focusing on the key variables of the study, namely the Altman Z-Score and its components. The results will be linked to existing literature and other relevant considerations discussed in chapter 2.
- Chapter 5: conclusions, discussion on the limitations of the study, and considerations for future research on the topic.

1. Definition

Mergers and acquisitions (M&A) represent a broad topic that can be analyzed from multiple perspectives, including sources of value creation, accounting, financial aspects, and transaction types. When focusing on a certain type of transaction, i.e. private equity and particularly leveraged buyouts, literature identifies several sub-types of deals. Among them, the two types that are the most frequently encountered in academic studies (as outlined by Renneboog and Vansteenkiste, 2017) are Institutional Buyouts (IBO) and Management Buyouts (MBO).

First, it is crucial to define private equity activities in general. Private equity involves investing capital in private companies in exchange for equity or ownership. Public companies, those listed on stock exchanges, can also be purchased by private investors. In such cases, the company becomes private, in a process known as delisting.

According to Romaniello, Dallochio, and Rodemeier (2024)⁴⁴, buyouts fall within a broad set of transactions and are distinguished from venture capital, growth capital, and distress investing by three key elements:

- Change in ownership structure ("buyout"): The buyer gains control of the target company, either majority or total control.
- Extensive use of debt ("leverage"): This involves a complete restructuring of the target company's capital structure via different debt and hybrid financial instruments.
- Specific characteristics common to LBO target candidates:
 - The ability to generate substantial and, more importantly, stable cash flows.
 - Low levels of existing financial debt.
 - Potential for growth, both organic and through future add-on acquisitions.
 - Opportunities to enhance operational processes.
 - A strong capital base in terms of assets.

⁴⁴ Romaniello, Dallochio, and Rodemeier (2024) refers to the Bocconi section of the thesis. The study's consultation has been authorized by the authors from April 2024 at the following [link](#).

Within the landscape of leveraged buyouts, this research focuses on the analysis of institutional buyouts and management buyouts, as they represent the most common transactions in this context.

1.1 Management Buyout

A management buyout is a transaction in which a company's management team acquires ownership control of the company through a combination of personal equity investment and external financing (Wright and Wood, 2009).

In negotiating the purchase, management benefits from several advantages:

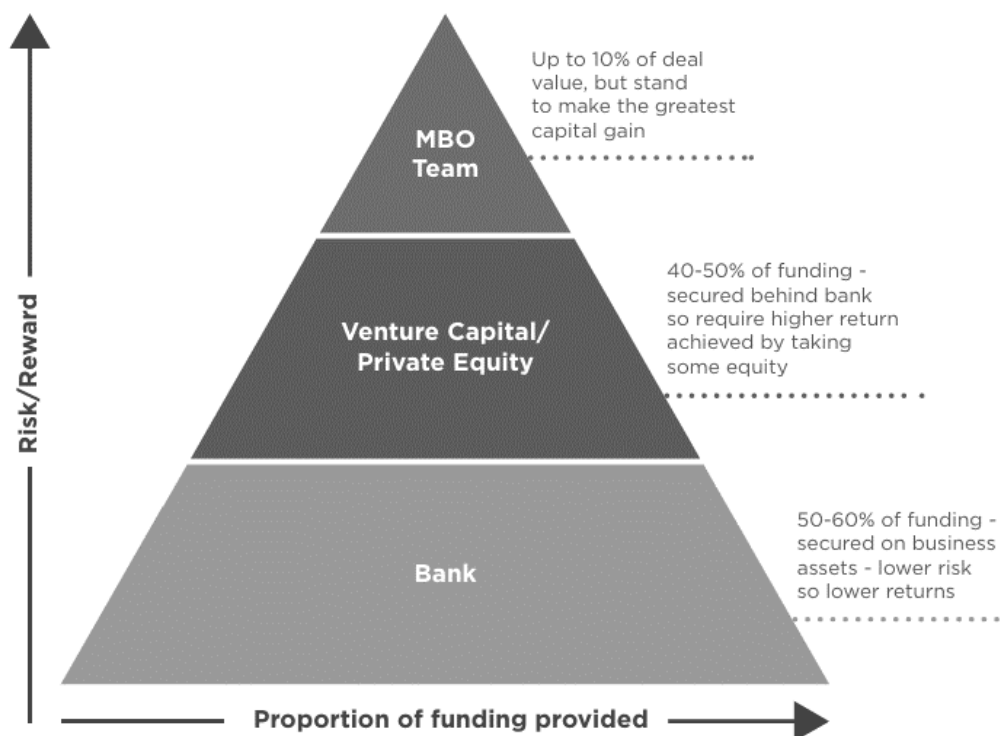
- *In-depth Knowledge*: Management has an extensive understanding of the company, surpassing any other potential buyer.
- *Certainty of Execution*: Management can execute post-acquisition plans more confidently due to their familiarity with the various stakeholders the company interacts with daily.
- *Established Relationship with the Seller*: Management has a well-established relationship with the seller, facilitating smoother negotiations.

There are several motivations that can drive management to acquire the company. Beyond the belief that they can create and extract additional value from the company, the acquisition can be incentivized by factors such as management rollover equity. If the management already owns a percentage of the shares, they can secure a loan to cover the remaining purchase price, provided the structure meets the lender's guidelines. As observed by Mao and Renneboog (2015), the greater the existing management's shares in the target company, the higher the likelihood of an MBO. Additionally, Wright et al. (1994) noted that in public-to-private buyouts, once central policy constraints are removed, companies can grow rapidly. Managers, armed with more information from the inside, may recognize this potential and be incentivized to privatize the company through an MBO. In other cases, as highlighted by Renneboog and Simons (2005), publicly traded companies may opt for an MBO as a defensive strategy against hostile takeover attempts.

Regarding the financing structure of an MBO, as illustrated in Figure 13, it typically involves funding from banks and private equity groups. Banks provide loans and financing through credit lines, while private equity groups offer equity financing,

demanding higher returns to compensate for the additional risk. Sometimes, the seller may also provide part of the financing. This typical financial structure allows management to acquire a significant portion of the company's equity with a relatively small personal investment. The leverage introduced into the structure, paid off with the company's profits, gives management the opportunity to achieve substantial gains, provided the company continues to perform at agreed-upon levels.

Figure 13: Financing structure of a MBO



Source: PEM Corporate Finance (<https://www.pemcf.com/wp-content/uploads/Practical-guide-to-MBOs-PEM-Corporate-Finance-download.pdf>)

Moving to the negotiation phase, the primary leverage for a management team pursuing a management buyout lies in their control over the sale process, aiming to prevent the seller from engaging with other potential buyers. The management can influence or expedite the process, positioning themselves as the main buyer due to their deep understanding of the company and its long-term growth prospects. While management teams may not always be the highest bidders, they can leverage non-monetary, intangible aspects. These factors include their commitment to the existing management team and concerns for the future of the company and the well-being of its employees. Emotional factors play a significant role in these scenarios, as many

sellers wish to entrust their life's work to people they trust. Management teams are often viewed as the most reliable buyers, capable of running the company in the spirit of the founder.

1.2 Institutional Buyout

An institutional buyout involves the acquisition of a controlling interest in a company by an institutional investor, primarily private equity firms. These investors create dedicated programs, often in the form of partnerships, to raise funds, invest in companies, and return profits to their investors.

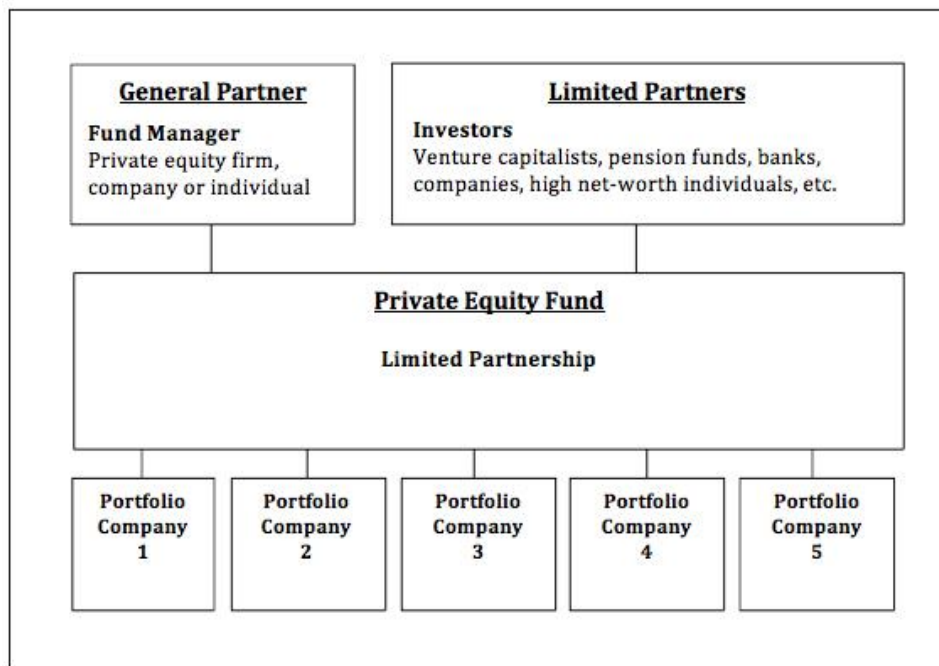
To understand the dynamics of IBOs, it is crucial to delve into the structure of a limited partnership, which is the primary organization for private equity investments globally. As described by Chambers, D. R., Black, K. H., & Lacey, N. J. (2018), this structure involves three main parties:

- Limited Partner (LP): Institutional investors who provide the capital needed for private equity investments.
- General Partner (GP): The fund managers who invest the clients' savings to achieve the declared financial goals.
- Target Company (or Private Equity-Backed Companies): The businesses that receive capital from these investments.

The general partner plays a pivotal role in investments, acting as the intermediary between the investors (limited partners) and the target companies. Capital flows from the limited partners to the general partner and then to the target company, with no direct contact between the limited partners and the funded companies. The primary motivation for limited partners to invest in private equity is the pursuit of higher returns compared to those offered by traditional financial instruments available in the market.

One key characteristic of IBOs is that institutional buyers aim for a predetermined return within a set timeframe, often between five to seven years, aligning with the planned return objectives set in the limited partnership agreement.

Figure 14: Limited partnership structure



Source: *Limited Partnerships and Private Equity*, Alexander R. Corrie

Regarding the technical aspects of the transaction, private equity firms, as managers of third-party capital, operate within specific time limits and follow a predetermined process that includes:

- i. Identifying a company to acquire.
- ii. Structuring the acquisition offer.
- iii. Presenting the offer to the shareholders of the target company.
- iv. Managing the company post-acquisition to increase its value.
- v. Exiting the investment by returning the capital and profits to the fund's investors.

These transactions can generally occur with the cooperation of the current owners of the company, but they can also be hostile, resulting in the acquisition despite resistance from existing management. Once the acquisition is complete, an institutional buyer may decide to retain the current management or bring in new managers. In most cases, institutional investors replace the existing management team with new executives as part of their value creation strategy. They often recruit industry experts to lead the company's operations, ensuring professional and experienced guidance (Gompers, P. A., Kaplan, S. N., & Mukharlyamov, V., 2023).

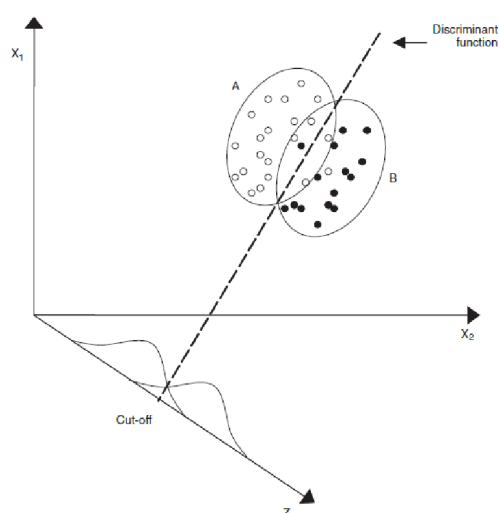
1.3. Default Prediction Theory

This study will adopt the definition provided by Resti and Sironi (2021), i.e. probability of default as "the likelihood associated with the insolvency of the counterparty, which declares bankruptcy or stops regularly honoring scheduled payments on the loan".

1.3.1. Discriminant Analysis Models

As outlined by Romaniello, Dallochio, and Rodemeier (2024), across models estimating default probability, credit scoring models are the most prevalent due to their reliance on economic and financial indices. These models are classified into three categories: discriminant analysis, regression models, and heuristic models. The research focuses on discriminant analysis, first theorized by Fisher (1936), which identifies variables⁴⁵ that best distinguish between "healthy" and "anomalous" firms. Figure 15 illustrates the Fisher model in the (simplified) case where healthy (group A) and anomalous (group B) companies are described by only two variables, x_1 and x_2 . A score generated by combining the two original variables is represented on the z -axis, and such a score is called discriminant function. Discriminant analysis, in its simplest version (linear discriminant analysis) constructs the score from a linear combination of the independent variables (in the case of the figure below, these are x_1 and x_2).

Figure 15: Graphical Summary of Linear Discriminant Analysis



Source: Resti and Sironi (2021)

⁴⁵ Typically accounting-based economic and financial ratios

In more general terms, given n independent variables, for the generic i -th firm, the score is:

$$z_i = \sum_{j=1}^n x_{ij} y_j$$

Here, the coefficients y_j in the linear combination are selected to obtain a score z that distinguishes as sharply as possible anomalous firms from healthy ones⁴⁶. As for the calculation of $\bar{y}$ (the vector containing the n coefficients y_j) to achieve this objective, it is proven⁴⁷ that:

$$\bar{y} = \Sigma^{-1} (\bar{x}_A - \bar{x}_B)$$

Where $\bar{x}_A$ and $\bar{x}_B$ are the vectors of average values of the n independent variables for the groups of “healthy” and “anomalous” firms, respectively, and Σ is the variance-covariance matrix for the n independent variables. Once $\bar{y}$ and thus the scores for each company are calculated, a threshold a (cut-off point) is determined, below which a firm is deemed “in danger”. This threshold is defined as follows:

$$a = \frac{1}{2} \bar{y} (\bar{x}_A + \bar{x}_B)$$

1.3.2. Default Probability and Altman Z-Score

The approach of using financial ratios to predict and analyze the probability of default has been originated in 1966 with William H. Beaver's study (Beaver, 1996). Beaver hypothesized that a specific set of indicators could distinguish between samples of healthy and distressed companies up to five years before a potential bankruptcy, and that these indicators could be incorporated into a multivariate analysis. Building on Beaver's model, Edward I. Altman (1968) refined the approach by reducing the number of indicators from 14 to 5, focusing on liquidity, profitability, leverage, and solvency.

The equation Altman derived for the i -th company is as follows:

$$Z_i = 1.2 x_{1,i} + 1.4 x_{2,i} + 3.3 x_{3,i} + 0.6 x_{4,i} + 0.999 x_{5,i}$$

The independent variables x_1 , x_2 , x_3 , x_4 and x_5 are defined as follows:

⁴⁶ In other words, the goal is to have the z_i of the healthy firms be as similar to each other and as different from the anomalous ones as possible.

⁴⁷ The proof is shown in Appendix 11A of Resti, A., & Sironi, A. (2021)

- x_1 : Working capital / Total Assets ("WC/A");
- x_2 : Retained earnings / Total Assets ("RET/A");
- x_3 : EBIT / Total Assets ("EBIT/A");
- x_4 : Market Value Of Equity / Book value of debt ;
- x_5 : Sales / total assets.

The initial version of Altman's model (1968) led him to conclude that a firm could be considered financially healthy if its Z-Score was above 2.99. Conversely, a score below 1.81 indicated a firm likely to fail, while scores in between these values fell into an area of ambiguity . With regard to the model evolution, initially it was applicable exclusively to publicly held manufacturing companies. However, it was later adapted to include privately held firms as well, giving rise to the Z' model. Furthermore, an additional variant of the model was developed to extend the analysis to non-manufacturing companies (Altman, Hartzell & Peck,1998). This variant, known as the Z'' model, can be outlined as follows:

$$Z''_i = 6,56 x_{1,i} + 3,26 x_{2,i} + 6,72 x_{3,i} + 1,05 x_{4,i}$$

In this case, there are four independent variables, and compared to the first version, the following differences can be observed:

- i. x_4 represents the ratio of the book value of equity to total liabilities ("E/L"), as for the Z'-Score.
- ii. Likelihood to fail is considered for Z'' scores lower than 1.1.

The discriminant analysis is used to directly generate an estimate of the default probability associated with individual firms analysed. Indeed, it can be demonstrated that, if the independent variables follow a multivariate normal distribution, then the probability that a firm will default is given by:

$$PD = p(B | x_i) = \frac{1}{1 + \frac{1 - \pi_B}{\pi_B} e^{z_i - \alpha}}$$

Where:

- $p(B|x_i)$ is the probability of belonging to group B (anomalous), given the vector of independent variables x_i .
- z_i represents the Z-score of the i-th firm.
- α represent the cut-off point;

- πB indicates the a priori default probability, namely that default probability which does not depend on the individual firm but on sector or market values.

In conclusion, the analysis that will be conducted is based on comparing the Z-score of the same company at two different times. Therefore, with reference to the equation above, it is possible to compare the Z-score trends in two separate periods and draw conclusions about the increase or decrease in the probability of default.

2. From Literature Review to the objective of the Thesis

As previously mentioned, leveraged buyouts represent a complex corporate acquisition strategy characterized by change in ownership, extensive use of financial leverage, and detailed control over the target company (Kaplan & Strömberg, 2009). These transactions often include tax benefits derived from debt usage and involve significant reorientation of corporate resources and capital structure.

This study focuses on a fundamental question: *are there substantial differences between management buyouts and institutional buyouts that may differently influence the default risk of target companies?* In other words, is it possible to identify specific peculiarities of MBOs and IBOs connected to a differentiated impact on the financial risk of the acquired firms?

The primary objective of this research is then to analyze and compare the operational and financial dynamics of MBOs and IBOs to determine if there are significant differences in how these transactions affect the default risk of target companies. This goal will be achieved through the analysis of a representative sample of leveraged buyout transactions, exploring various financial and operational indicators, with a specific focus on the Altman Z-Score. In other words, firstly it will be analyzed the overall effect on the score, and after it will be disentangled in its single components previously defined, i.e. x_1 , x_2 , x_3 and x_4 .

2.1 Literature review: relevant differences between the two transactions

2.1.1 Acquisition purpose

The primary difference between management buyouts and institutional buyouts stem from the intentions of the buyers. According to Hanney (1986), managers involved in an MBO are primarily motivated not by capital gains but rather by the opportunity to control their own destiny, free from political and bureaucratic constraints, and to safeguard their jobs. In contrast, in IBOs, the key stakeholders, particularly the general partners, focus their acquisition decisions on capital gains crucial for generating returns to investors and earning related fees. Operationally, this implies a defined timeframe

to achieve profits, often involving rapid and strategic changes in governance (Gompers, Kaplan & Mukharlyamov, 2023).

2.1.2 Earnings Management

In their study, Yaping Mao and Luc Renneboog (2015) investigated whether earnings manipulation occurs prior to leveraged buyout transactions in the United Kingdom during the second wave of buyouts (1997-2007). They distinguished between earnings management through accruals, real earnings management via sales and production, and asset revaluation. Their goal was to examine how and why earnings manipulation occurs in LBOs, specifically:

- i. Managerial incentives to manipulate earnings downward to lower the stock price and acquire the company at a reduced price in an MBO transaction.
- ii. Incentives to manipulate earnings upward to increase the company's debt capacity and facilitate the LBO transaction.

They found that target companies engaged in negative earnings manipulation in the year preceding the buyout transaction, using both accrual management and real earnings management.

Mao and Renneboog (2015) specifically demonstrated that MBOs are associated with significantly higher accruals manipulation—approximately double in terms of accruals adjusted for industry size—compared to IBOs. This finding is unsurprising as management teams considering an MBO may seek to use earnings understatement to negatively influence the acquisition price. While not as pronounced, they also found some evidence of negative earnings manipulation in IBOs, reflecting ex ante uncertainty about the type of buyout transaction that will ultimately occur.

This degree of downward accrual manipulation is economically significant, with abnormal accruals in MBOs representing approximately 30% of earnings. However, their hypothesis regarding financial incentive, expected to manifest in mitigated downward earnings manipulation through asset revaluation, was not supported by the data. They concluded that asset revaluation is not a significant channel for earnings manipulation.

Moreover, their study suggested that even sophisticated professionals, such as auditors and financial analysts, struggle to detect accrual anomalies (Bradshaw,

Richardson & Sloan, 2001). Similarly, research by Bhojraj and Swaminathan (2007) indicates that creditors, including bond investors, do not accurately price accruals. Consequently, the likelihood of detecting manipulation appears low. In the other case, if manipulation is discovered, managers may more easily justify downward manipulation with a conservatism in accounting principles.

2.1.3 The Information advantage or under-pricing hypothesis

The hypothesis of informational advantage or underpricing is rooted in the concept of asymmetric information. This theory suggests that managers possess privileged or insider information that allows them to better know the "fair" value of the company. According to Renneboog and Vansteenkiste (2017), this issue is particularly relevant for small publicly traded companies, which often struggle to use the stock market to finance growth. However, directly studying this hypothesis is complex. Therefore, Kaplan (1989b) and Smith (1990) suggest using the following variables to investigate potential informational advantage:

- The number of executives and managers not participating in the buyout transaction.
- Comparison of post-buyout performance against financial projections provided by the management team to shareholders prior to the agreement.
- Comparison of the performance of companies whose management buyout proposals were not completed successfully.

Both studies, along with Lee (1992), have excluded the presence of privileged information in MBOs. However, Harlow and Howe (1993) found that LBO offers made by teams including management members are preceded by significant abnormal insider purchases, whereas third-party LBOs do not show such abnormal purchases in the pre-announcement period. This suggests that MBOs may be characterized by managers leveraging insider information.

Overall, the difficulty in detecting the use of privileged information and misconduct by managers in a management buyout has long been recognized. As noted by Lowenstein (1985), suspicions regarding MBOs relate to timing and the pricing of the operation. The author highlighted several suspicious practices, including:

- Reduction or smaller increases in dividends compared to market expectations.

- Executives avoiding meetings with financial analysts, thus withholding critical information.
- Overfunding of benefits for employees.
- Acceleration of investments in long-term projects, which can negatively impact reported earnings.
- Persuading auditors to estimate expenses more conservatively.

These practices can contribute to masking the true financial state of the company, facilitating acquisition at a price below its actual value and benefiting the managers involved in the buyout.

2.1.4 Governance changes

The distinction between management buyouts and other forms of leveraged buyouts is particularly evident when considering the role of management in value creation:

- In an MBO, the existing management team plays a crucial role by acquiring a significant stake in the company. They leverage their deep knowledge and expertise in operations, corporate culture, and strategic vision of the company. This continuity in leadership in MBOs ensures a smoother and more stable transition, minimizing disruptions that could arise from a management change. Moreover, the coexistence of management team and ownership fosters a collaborative environment where long-term strategic goals can be pursued effectively in unison. The management team's motivation to enhance performance and create value is inherently strong due to their financial participation.
- Institutional investors in IBOs aim to create value through various levers such as revenue enhancement, governance improvement, and cost reduction. Crucially, they often replace top management after their investment to ensure that leadership is aligned with their strategic goals and capable of executing necessary changes effectively. This approach is underscored by research from Gompers, Kaplan, and Mukharlyamov (2023). Similarly, Biesinger, Bircan, and Ljungqvist (2023) emphasize that buyouts frequently involve optimizing the capital structure, facilitating additional acquisitions, and modifying the product

or service mix, with management replacement being a key aspect when the existing team lacks the skills to execute the business plan.

In summary, while MBOs capitalize on the strengths and continuity of the existing management team, IBOs often rely on introducing new management to address deficiencies and implement strategic improvements.

2.2 Research focus: potential different effects on Z-Score's and components

Given the four previously detailed points delineated in the literature, it is possible to infer potential effects on the Z-Score measure, specifically on its individual components. These perspectives can be seen as potential hypotheses to be tested in the descriptive analysis carried out in section 4.

This section, therefore, acts as a bridge between the literature review and data analysis. However, rather than being a mere connector, it represents the key section through which this research identifies a gap in existing academic studies. Indeed, this research fill the gap between the previously mentioned academic literature that has focused on the distinctive characteristics of MBOs (Hanney, 1986; Yaping Mao & Luc Renneboog, 2015; Renneboog & Vansteenkiste, 2017; Lee, 1992; Kaplan, 1989; Smith, 1990; , Harlow e Howe, 1993; Lowenstein, 1985) , and other studies that have analyzed the effects of leveraged buyouts (both IBOs or MBOs) on the performance of target companies (Amess, 2003; Harris et al., 2005; Lichtenberg & Siegel, 1990; Wilson, Wright, Siegel & Scholes, 2012).

2.2.1 Effects on the variance of results

As previously mentioned, Institutional Buyouts differ from Management Buyouts because they often involve the replacement of existing management, disrupting established dynamics with stakeholders such as customers, suppliers, and service providers. This replacement can cause instability and temporary operational discontinuity as the new management establishes new processes and relationships.

Institutional investors typically aim to achieve high returns within a set period, driving them to maximize efforts to "run the machine at full speed". In this context, the new owners may have conflicting interests with other stakeholders, such as employees,

customers, and suppliers. In other words, the primary focus on generating returns for the investors can conflict with the broader interests of the company, such as long-term sustainability and stakeholder well-being. This “aggressive” approach can potentially increase management and operational risks, akin to corporate “accidents,” due to the pressure to deliver quick results.

Consequently, the Altman Z-score may exhibit much greater variability in companies involved in an IBO compared to those in an MBO. The need for rapid financial performance improvements can lead to increased volatility in the components of the Altman Z-score, reflecting the heightened risks associated with the aggressive approach of IBOs.

In summary, while MBOs benefit from continuity and alignment of interests between management and new owners, IBOs tend to introduce greater variability and risks due to management replacement and pressure to achieve quick results.

2.2.2 Effects on operating improvements

On the other hand, it's important to consider that professionals involved in Institutional Buyouts are highly skilled and accustomed to managing such situations. These professionals possess extensive industry networks, including business partners and potential clients. This network can facilitate strategic partnerships, collaborations, and business development opportunities for the target company, allowing it to expand its market and access new opportunities. This advantage can offset some of the initial issues caused by management changes, significantly contributing to long-term value creation.

At the same time, managers involved in MBOs have an intimate knowledge of the company they are acquiring. This deep understanding allows them to identify and implement operational improvements more effectively and swiftly in the short to medium term. Additionally, although one of the motivations for an MBO is the belief that the company has growth potential under proactive management, as mentioned above, managers often engage in earnings management before the buyout to artificially lower the company's profitability. After the transaction, these artificially suppressed earnings gradually emerge, leading to increased profitability that is not due to real operational improvements but simply because the initial profitability was

artificially reduced. This phenomenon can result in an apparent improvement in company performance in the years following the acquisition, reflecting the restoration of profitability rather than actual operational progress.

In other words, from a different perspective, acquisitions by institutional investors generally involve a higher risk profile, offering the potential for significant outcomes but with greater volatility. On the other hand, management buyouts tend to have a more stable impact, with effects often related to earnings management and information asymmetry. Ultimately, the predominant impact among MBOs and IBOs on profitability remains uncertain. While the expertise and resources in IBOs can drive growth, the information asymmetry and initial earnings management advantages in MBOs may yield more immediate operational improvements alongside lower volatility.

2.2.3 Effects on Business Size and Assets

Access to a larger pool of capital enables a significant increase in company assets and revenues without altering the leverage ratio, especially thanks to the injection of equity capital in addition to debt financing. This phenomenon is particularly evident in financial transactions led by private equity funds. In such operations, private equity funds not only use debt but also make substantial equity injections, significantly boosting the target companies' assets and, consequently, their revenues through means such as inorganic expansion. This diversified capital flow allows the business to grow more rapidly and consistently under the guidance of institutional investors compared to what might occur under management in a Management Buyout. However, it is important to note that asset growth driven by a substantial influx of capital does not necessarily translate into greater efficiency and productivity. This is evident when the income statements do not show the same improvement in margins as seen in the balance sheets.

On the other hand, in Management Buyouts owners do not have access to the same level of capital that a private equity fund can offer. Consequently, companies undergoing an MBO may not be able to grow at the same pace as those supported by private equity. Nevertheless, it is also possible that managers, having a deeper understanding of the company and its operational processes, can utilize the available resources more efficiently, leading to improved operational profitability.

Therefore, it could be expected that the assets and revenues of companies will grow more under the ownership of private equity operators compared to MBO cases. This increase is fueled by the significant capital influx that private equity funds can mobilize. However, the effect on the actual profitability of these assets remains uncertain, especially in the presence of exponential growth. In other words, while the value of assets and revenues may increase considerably, the company's ability to translate this increase into actual profitability is not guaranteed.

2.2.4 Effect on Net Working Capital

The time constraints imposed on private equity funds orient their objectives towards short-term value creation, unlike in Management Buyouts. For this reason, besides increasing operational value by enhancing the size and profitability of the business, it is crucial for the company to generate sufficient liquidity to repay the incurred debt. Conversely, management in MBOs, not being bound by imminent holding time restrictions, has greater flexibility in optimizing business efficiency without significantly increasing operational risk.

To this extent, one of the main strategies used by private equity funds to improve efficiency is the management of the working capital cycle. Specifically, the goal is to reduce accounts receivable and inventory while increasing accounts payable. This approach leverages operational efficiencies, allowing the company to hold less capital inefficiently tied up and to have more liquidity available to service financial debt. However, as noted by Romaniello, Dallochio and Rodemeier (2024), this strategy can compromise the company's short-term liquidity buffer, thereby increasing the risk of default. As a result, one can expect a more significant reduction in working capital in companies acquired by institutional buyouts compared to those in management buyouts.

In summary, the difference between Institutional Buyouts and Management Buyouts also manifests in the management of working capital. Private equity funds, needing to meet shorter time horizons, are more inclined to quickly optimize working capital to free up financial resources. In MBOs, on the other hand, managers can adopt a more balanced and sustainable strategy in the long term, focusing on operational improvements without necessarily sacrificing the company's financial stability.

3. Data and Methodology

Following Romaniello, Dallochio, and Rodemeier (2024), for the default probability, which is the measure at the center of the research, this study associates it with the Altman Z-score, since the use of such a score offers mainly two advantages:

- It allows considering independent variables that have the same financial significance regardless of firms' industry or geography. Moreover, these variables, when considered one by one, are able to clearly explain a given business dynamic. In this way, it is possible, on the one hand, to contextualize the result to the entire population of companies and, on the other hand, to link value creation strategies to the independent variables considered in the index.
- It enables the examination of a limited number of variables that nevertheless manages to provide meaningful information. This leads to the benefit of greater availability and reliability of data.

Regarding the choice of the specific score, Z" was chosen in the context of this research (Altman et al., 1995). According to Altman, Iwanicz-Drozowska, Laitinen, and Suvas (2014), the omission of the variable sensitive to sector-specific characteristics, i.e. the asset turnover, makes the Z"-Score a more versatile tool for financial analysis, as it enables its application across a broad spectrum of sectors .

Romaniello, Dallochio, and Rodemeier (2024) also outlined one of the main challenges in private equity research: the data availability. Since private companies are not publicly traded, they do not have the same disclosure requirements as publicly traded companies, particularly firms in the United States (except those that have issued public bonds). However, European companies are required to publicly present financial statements. In this study, therefore, the focus has been on LBO transactions targeting European companies, with no restrictions on the private equity investor's country of origin. Three different databases were used to identify LBO transactions, targets and comparables financial data: Zephyr, Orbis, and Capital IQ. It is important to note that from an initial sample retrieved on Zephyr, further selection was made by including only target companies for which financial data was available in the two years prior to and three years after the transaction. This is a pre and post buyout time horizon often used in the literature (Kaplan, 1989; Boucly et al., 2011) Regarding the search

for transaction data, from Zephyr there have been retrieved all transactions with the following simultaneous characteristics:

- i) Type of transaction: institutional buyout, managerial buyout⁴⁸.
- ii) Type of sub-deal: leveraged buyout.
- iii) World region (Target): Western Europe.
- iv) Time period: completion date from 01/01/2003 to 01/01/2017. This time horizon was chosen with the intention to cover the performance effects of two distinct cycles of LBOs: the “third” (2003-2007) and the “fourth” (2012-2016)⁴⁹. At the same time, the time frame was also chosen to investigate the impact of LBOs on firm performance during periods of economic uncertainty, particularly in 2008, while not considering the analysis of effects on targets in the Covid-19 period⁵⁰.

Along with these four filters, two additional factors have been considered. Firstly, it has not been filtered by target status. Thus, companies were selected regardless of being listed or unlisted, and regardless of their existing legal status. As pointed out by Sharjil and Haque (2023), an advantage of the Zephyr/Orbis platform over other databases is that it does not remove companies after a few years of inactivity, thereby minimizing the problem of selection bias. Therefore, regarding the legal and financial status of firms, in this research all the following cases were included: active firms, bankrupted, ceased, in liquidation, closed due to bankruptcy, in insolvency, in bankruptcy proceedings, subject to a rescue plan, and subject to a restructuring plan. Finally, secondary acquisitions were excluded because companies previously acquired by

⁴⁸ Zephyr classifies institutional and management buyout transactions as follows: *institutional buy-out* is “an acquisition where a private equity firm has taken a 50% stake or more in the target company or is the parent of the acquiror”; *management buy-out* is “a transaction where all or some of the existing management of the company buy at least 50% of the company from its existing owners”.

⁴⁹ LBOs have experienced four notable cycles. The first cycle began in the 1980s with the rise of high-yield bonds, culminating in KKR's \$25 billion acquisition of RJR Nabisco in 1988 (Gaughan, 2010). The second cycle, starting in the 1990s, featured reduced leverage and a shift to senior bank debt, ending with a decline in LBOs volume due to the dot-com bubble burst (Guo, Hotchkiss, & Song, 2011). The third cycle, from around 2004 to the 2007-2008 credit crunch, saw high transaction volumes and record multiples, driven primarily by the availability of syndicated bank debt (Acharya, Franks, & Servaes, 2007). The fourth cycle began with limited LBO activity during the “post-crisis” period (2009-2011) and transitioned into the “post-QE” period (2012-2016), characterized by renewed market confidence and significant deal opportunities. (Gatti, Chiarella, Warren, & Ragione, 2015).

⁵⁰ Analyzing the effects while considering the Covid-19 impact should involve examining the situation one year prior the LBO and three years afterward. Since data for 2023 are not available, analyzing the performance outcomes at T+3 is not feasible. Therefore, for consistency, it has been decided to only consider the effects of buyouts up to the pandemic, thus until 2019. This rationale underpins the decision to stop at January 1, 2017.

private equity investors may have higher debt levels than normal companies, which might affect the assessment of their default probability. Once identified the deals, using the BvD identifier matching system, the following data on the targets were searched within Orbis: Two Digit NACE⁵¹, Revenue, Asset, EBIT, Shareholders' Fund, Current Asset, Current Liabilities, Retained Earnings. In addition, for the data not available on Orbis, starting from the information about the date of completion of the transaction, through the Capital IQ software the same types of financial data have been retrieved. As a result, this research studies a total of 92 transactions. The selected sample of transactions, as shown in Table 10, covers a time span characterized by different economic cycles. It ranges from periods of low interest rates (2003-2006) to phases with slightly higher rates (2006-2008), through periods of market dislocation and recovery (2009-2011), to low interest rates environments again (2011-2016). In this context, given the evidence that private equity funds' recourse to debt is sensitive to market conditions, it can be concluded that this research examines all possible responses of private equity funds to different macroeconomic situations.

Table 10: Distribution of the sample by period

Transaction Year	# of Deals	% of Deals
Post Dot.Com - Post Sovereign Debt Crisis ('03-'11)	17	18%
Post-QE ('12-'16)	75	82%

Source: own elaboration

Regarding the specific type of buyout, Table 11 shows that 70 % of the transactions are IBO, while 30% are MBO.

Table 11: Distribution of the sample by LBO Type

LBO Investor	# of Deals	% of Deals
Institutional Buyout	64	70%
Management Buyout	28	30%

Source: own elaboration

In addition, Table 12 refers to the non-financial characteristics of the targets. Geographically, 39% are located in UK, 29 % in France, 15 % in Italy, and the

⁵¹ The NACE code, acronym for “Nomenclature statistique des Activités économiques dans la Communauté Européenne”, was developed in 1970 by Eurostat, the statistical arm of the European Commission. This classification scheme is employed to harmonize the categorization of economic and industrial activities within the countries of the European Union

remaining 9% in the Netherlands, Spain, Germany, and Belgium. This is a geographical sample representation in line with the distribution registered in 2022, described by Invest Europe (2023).

Table 12: Distribution of the sample by Geography

Target Geography	# of Deals	% of Deals
Belgium	3	3%
Germany	7	8%
Spain	4	4%
France	27	29%
United Kingdom	36	39%
Italy	14	15%
Netherlands	1	1%

Source: own elaboration

In terms of sectors considered, as can be seen from Table 13, the sample shows a uniform distribution across sectors.

Table 13: Distribution of the sample by GICS Sector

Sector	# of Deals	% of Deals
Materials	8	9%
Industrials	19	21%
Consumer Discretionary	23	25%
Consumer Staples	3	3%
Health Care	4	4%
Information Technology	8	9%
Utilities	8	9%
Real Estate	10	11%
Other	9	10%

Source: own elaboration

4. Descriptive analysis of results

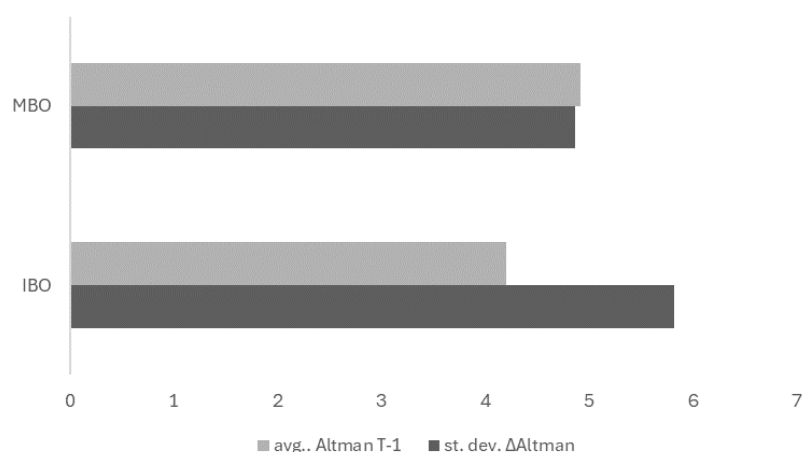
After delineating the literature addressing the potential divergent effects on target firms between management buyouts and institutional buyouts, this section will present some descriptive evidence based on the sample mentioned previously. Specifically, this chapter will be divided into two subsections: the first will show the evidence related to the Altman Score at a general level, while the second will analyze the main drivers of this effect, including more detailed considerations that relate back to the observations in section 2.2.

4.1. Descriptive analysis of the overall effect on the score

Before proceeding to analyze the results, it is important to clarify some terms used in the graphs. Specifically, "T-1" refers to the year before the leveraged buyout, while "T+3" indicates the third year after. This time horizon is commonly used in the academic literature to analyze and compare the effects of leveraged buyouts on target companies (Bernstein, Lerner & Mezzanotti, 2017; Boucly, Sraer & Thesmar, 2011).

With respect to the analysis under study, the graph below compares management buyouts and institutional buyouts on the standard deviation of the difference between the Altman Score measured in year T-1 and that measured in year T+3. The graph also takes into account the initial average of the Altman Score for the two types of transactions.

Figure 16: MBOs and IBOs, comparing the st.dev. of the difference between Altman Z-Score in T+3 and in T-1

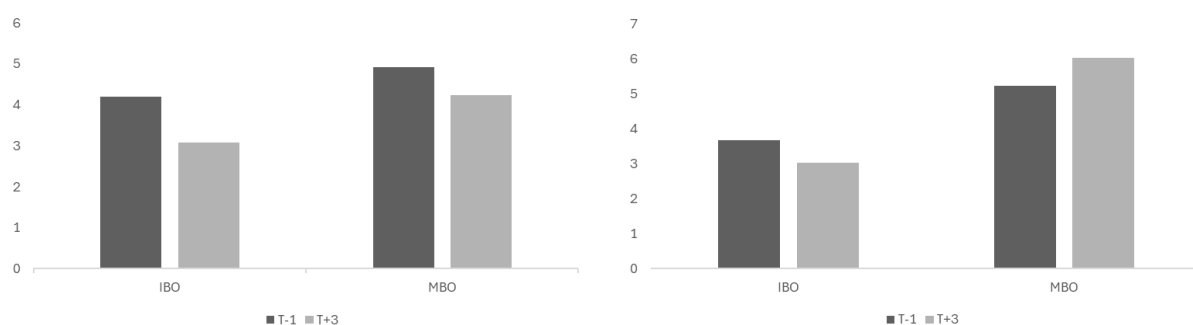


Source: own elaboration

From the graph above, it can be seen that even with a lower Altman Score at entry, insitutional buyouts record higher volatility in the difference between Altman Score of the target at T-1 and at T+3 than management buyouts. Given the evidence shown in the data, it appears that the first point presented in section 2.2. is validated. In particular, the difference in the volatility of the results can be explained by the fact that in management buyouts there is managerial continuity, without a disruption in the daily operations of the target. As for institutional buyouts, the replacement of management that occurs in most cases leads, as outlined in more detail in section 2.2.1, to a potential upheaval and disruption in the relationship with all stakeholders, from customers to suppliers, from competitors to owners.

Therefore, having noted a difference in the volatility of the results, it is worth describing and comparing the overall impact on default risk. The following figure shows the results recorded, at average and median level.

Figure 17: MBOs and IBOs, difference on the impact on Mean (on left) and Median of targets' Altman Z-Score



Source: own elaboration

One main aspect can be seen from the results above: looking at both the mean and median, managerial buyouts have a less negative effect than institutional buyouts on the Altman Score of target companies. In particular, looking at the left-hand graph (mean), compared with a total percentage decrease of 27 percent over the 3-year holding period for institutional buyouts, managerial buyouts show an average decrease of 14 percent, almost half. Moreover, looking at the median data, this evidence becomes even more pronounced, with management buyouts recording improvements in the Altman Score of targets (+16%), while institutional buyouts record -18%. Given the results shown, a possible reason could lie in the hypotheses outlined in section 2.1.3, namely the information asymmetry of managers who, in deciding to initiate a buyout, have better in mind which areas to improve in a timely manner to improve the business quickly.

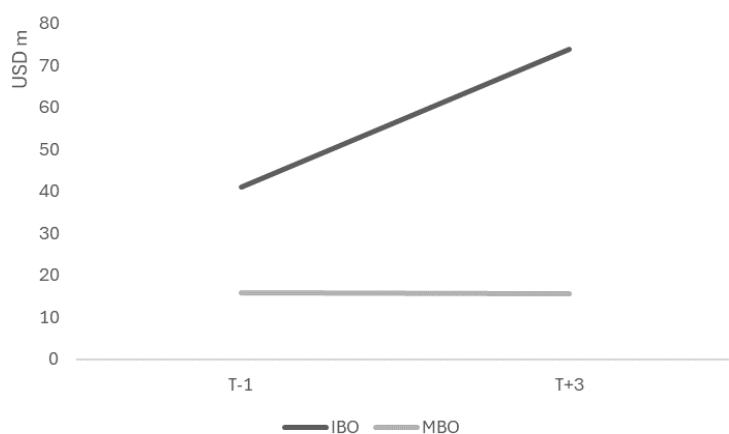
To conclude the first part of the analysis, the descriptive analysis of the results on the Altman Score shows that managerial buyouts tend to provide greater stability on default risk's movements and a significantly less negative effect on the Altman Score than institutional buyouts. This evidence can be attributed to managerial continuity and the ability of managers, given greater information asymmetry, to identify and act quickly on critical areas of the business.

4.2. Descriptive analysis of the effect on individual score components

The purpose of this section is to decompose the overall result on the Altman score described in the previous section, analyzing what are the main drivers of that evidence. Given the high volatility of the data, it is appropriate to analyze this phenomenon by taking the median as a reference. In fact, when a dataset has a large enough variance, it may be more appropriate to use the median rather than the mean for analysis because, being unaffected by outliers, the median represents the midpoint of the data and provides a more robust measure of central location when the data have high variance or skewed distributions.

Focusing on the current section, it will be divided into 4 parts, each relating to individual components of the Altman Score, analyzed and compared across MBOs and IBOs, in T-1 and T+3. Before delving deeper, however, it is worthwhile to show how a key determinant of the Altman Score and of its individual components, namely asset moves, as illustrated in the chart below.

Figure 18: change in Asset level between T-1 and T+3, MBOs vs. IBOs



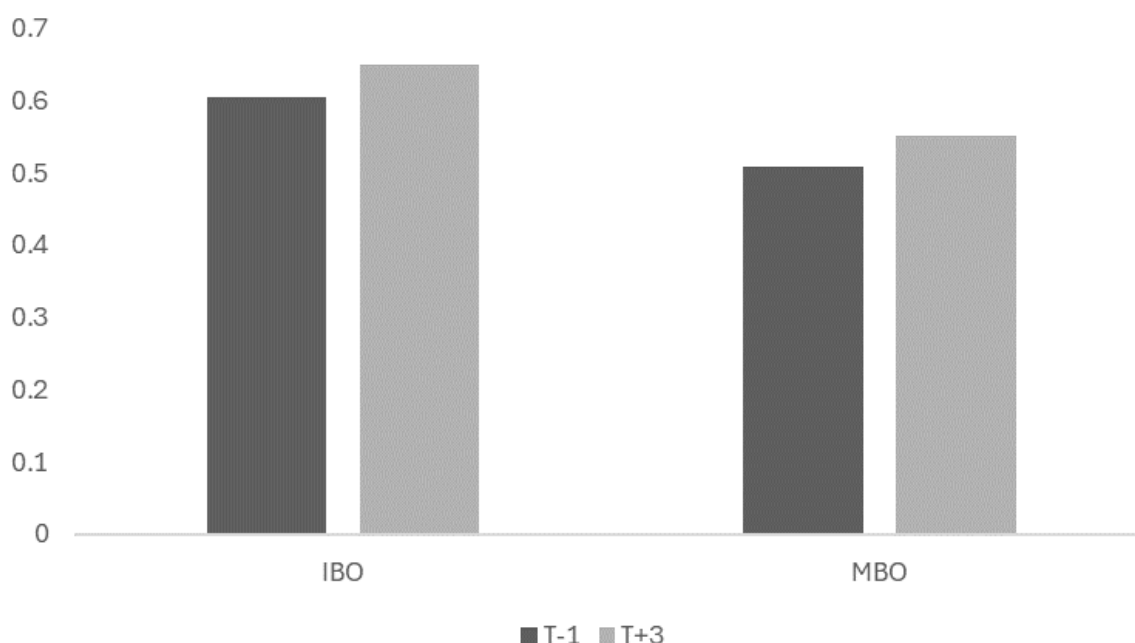
Source: own elaboration

As evidence of the points made in section 2.2.3, the institutional buyers' larger pools of capital enable their portfolio companies to grow disproportionately more than management buyouts' targets. The graph above shows an overall growth of 80% for institutional buyouts, compared to a growth of -0.011 % in the case of management buyouts, reflecting a completely opposite management policy. Therefore, in contextualizing the following analysis on the single indices, it should be considered a different speed of business growth between MBOs and IBOs.

4.2.1 Equity to Debt

The main factor characterizing the transactions in the sample is the use of a large amount of leverage to purchase the target; from the graph below it can be seen that the movement of leverage was not a key determinant of the difference in the effects on the Altman Score.

Figure 19: MBOs and IBOs, comparing the movement of Equity to Debt between T+3 and T-1



Source: own elaboration

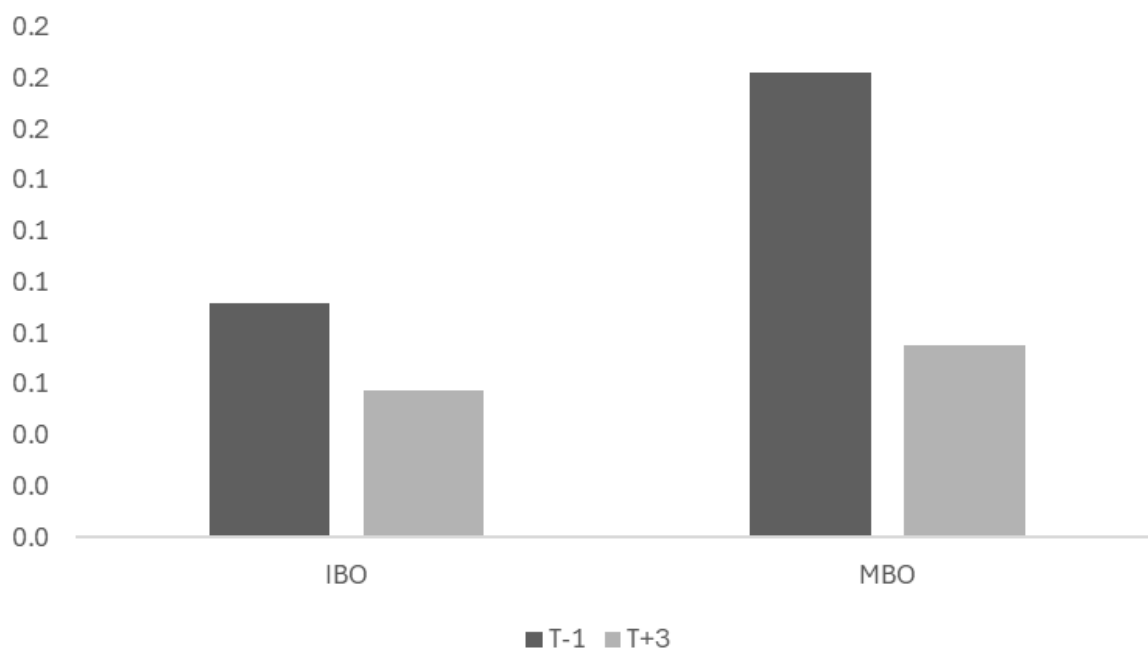
As can be seen, in both cases the median level of equity over debt has increased in the post-transaction period, with the target companies even reporting a stronger financial position than 4 years earlier; however, there are no significant differences between management buyouts (where the median ratio increase is 8.3%), compared to management buyouts where there is an increase of 7.6%.

Therefore, the data analyzed above lead to the idea that the greater asset growth in IBOs compared to MBOs is related to a proportionately greater use of debt and equity, rather than just a greater drawdown of equity (as outlined in paragraph 2.2.3).

4.2.2 EBIT to Asset

As for the second component of the Altman Score, namely EBIT to Asset, the chart below presents the main evidence from the sample.

Figure 20: MBOs and IBOs, comparing the movement of EBIT to Asset between T+3 and T-1



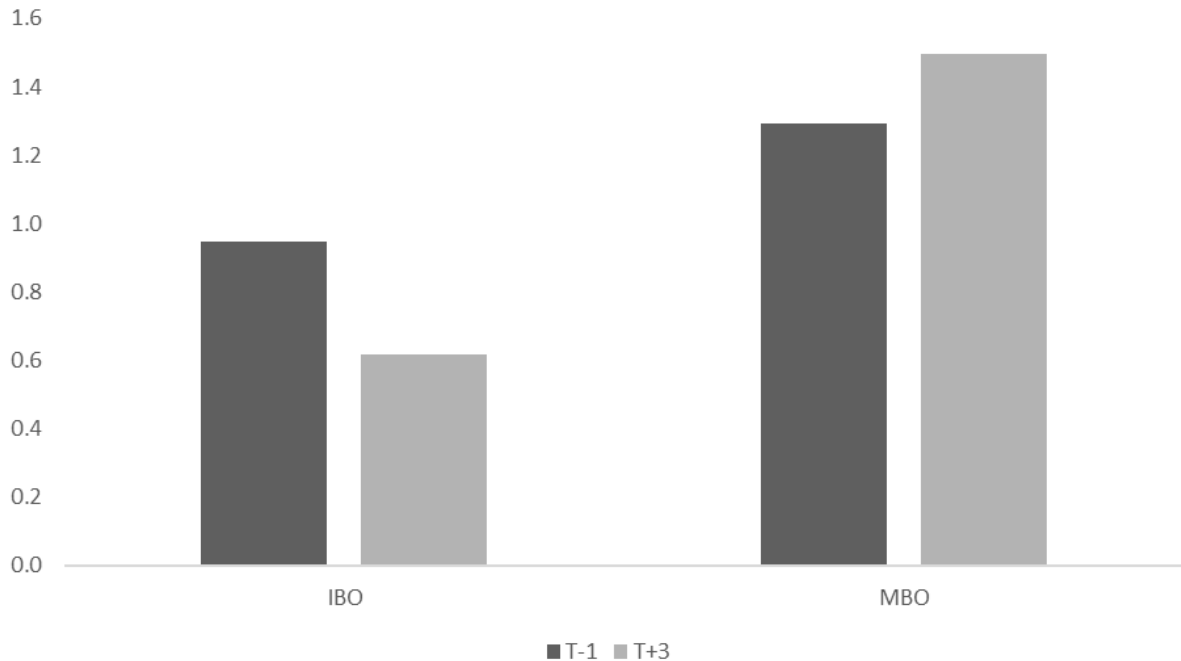
First, it can be seen that targets subject to management buyouts at entry have business models that are more profitable in operational terms, but then decline tremendously (c.a. 59%), compared to institutional buyouts where, assuming conspicuously greater asset growth, the decline in profitability is 38%.

However, the trend shown above would seem doubtful given the assumptions presented in section 2.2.2. Therefore, it is important to stick to the income statement and the analysis of business efficiency, this time focusing on the top line, that is, the Asset Turnover ratio.

From the graph below it is possible to note that in the case of MBOs, revenues grow more than proportionally relative to assets, such that the ratio increases by 16 percent.

The case of institutional buyouts is different, where the ratio decreases and revenues grow, but not at the relentless pace of assets.

Figure 21: MBOs and IBOs, comparing the movement of Revenue to Asset between T+3 and T-1



Source: own elaboration

The analysis of revenue relative to assets, in conjunction with that of EBIT, allows to present some hypotheses about the causes behind such movement of the EBIT/Asset component.

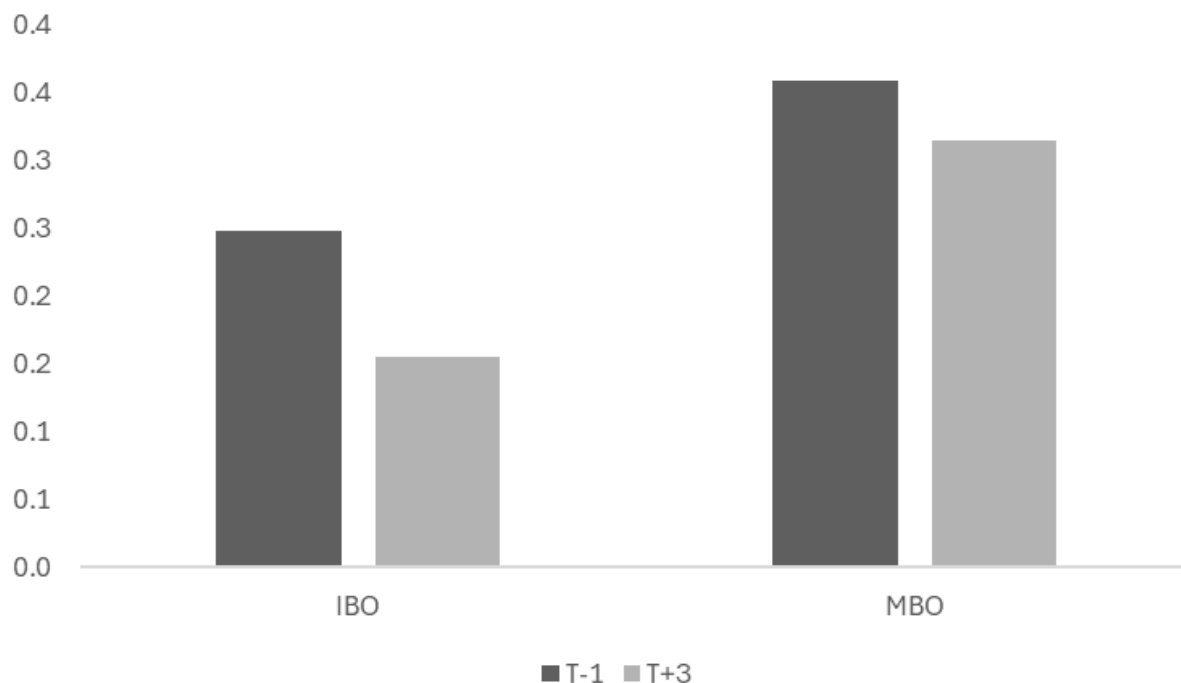
- i. In management buyouts, inexperience in handling the overlapping situation of “managers & owners” leads the business to become less productive. So as revenue and assets increase, marginality could decrease.
- ii. Having a longer-term view and less pressure from stakeholders and regulators, management could increase the so-called noncash costs (depreciation and amortization), to take benefit from tax shields.

4.2.3 Working Capital to Asset

This section is closely related to the points made in chapter 2, particularly in the section 2.2.4. when discussing cash flow optimization, with special focus on net working capital.

In this regard, the graph below shows the change in the ratio of working capital to assets for MBO and IBO, between T-1 and T+3.

Figure 22: MBOs and IBOs, comparing the movement of Working Capital to Asset between T+3 and T-1



Source: own elaboration

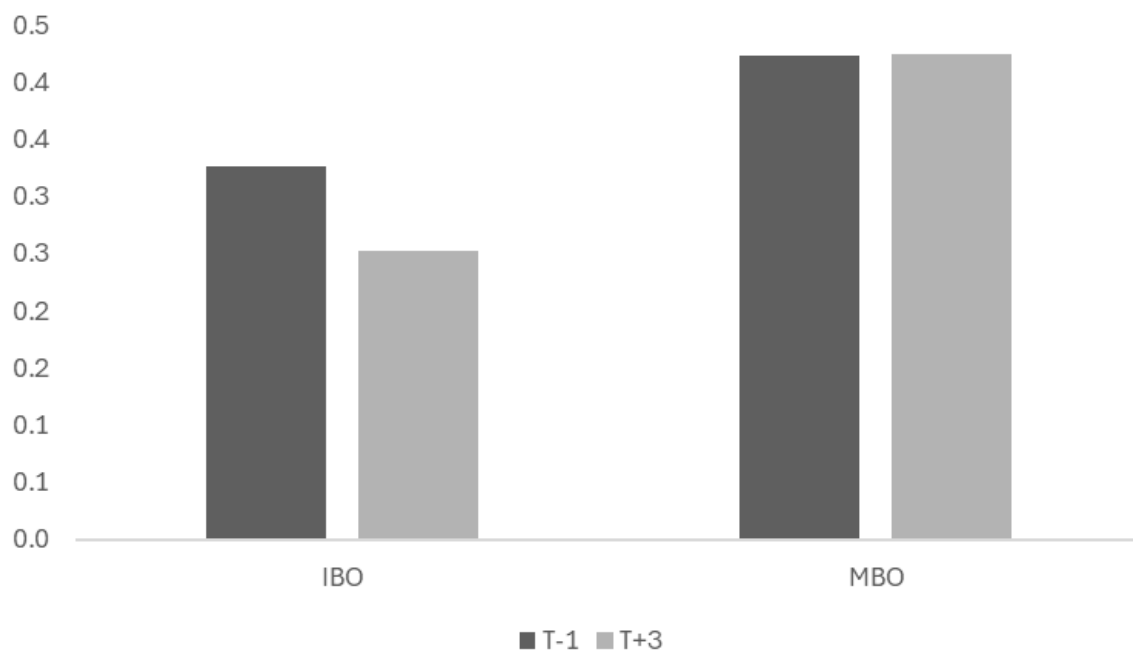
As can be seen, there is a conspicuous difference in the change in working capital on assets between IBOs and MBOs. More specifically, the former show a decrease of 37 percent, while the latter show a decrease of 13 percent, almost equal to one-third.

This evidence is in line with what was outlined in section 2.2.4, in which greater downward movement in working capital on assets was linked to the aim by institutional buyers to maximize value creation as quickly as possible, including through cash generation related to a lower level of working capital relative to total assets.

4.2.4 Retained Earnings to Asset

As for the self-financing ratio of the business, the chart below shows the detail of the change in retained earnings on assets.

Figure 23: MBOs and IBOs, comparing the movement of Retained Earnings to Asset between T+3 and T-1



Source: own elaboration

As can be observed, while the self-financing ratio in institutional buyouts has decreased (by 23%), in management buyouts the ratio remains roughly stable.

The greater decrease in retained earnings over asset may be the effect of a different policy related to dividends.

From one side, IBO can see the dividends as a partial payment to the investors, i.e. capital inflows that can improve investment return metrics⁵². In other words, instead of re-investing the profits into the business, the short termism of private equity funds leads them to distribute dividends. On the other side, the shareholders long termism does not require the business to lose some self-financing capital, which is essential for the overall risk of default.

⁵² Together with net multiple, i.e. capital received to capital invested, limited partners evaluate the general partners also on IRR, which is positive impacted by early payments.

5. Final Considerations

5.1. Conclusive Remarks

In the academic context of research on the effects of leveraged buyouts on target companies, this study aims to move beyond the general classification of LBOs and delineate differences at a subset level. Specifically, as institutional buyouts and management buyouts are the main subcategories of LBOs, the study seeks to deepen the theoretical differences between these two transactions and subsequently describe their effects on target companies.

Following the framework outlined by Romaniello, Dallochio, and Rodemeier (2024), the focus of the research has been on the risk of default, precisely defined and measured using the Altman Z-Score. By studying 92 transactions over the past two decades, the study provides descriptive evidence supporting existing academic theory.

Firstly, the study highlights that the effect of MBOs on the Altman Z-Score of target companies is less negative compared to IBOs. A possible explanation for this can be found in the literature and is linked to two main factors:

- i. In MBOs, the management acquiring the company could have greater informational asymmetries compared to IBOs, and therefore more knowledge about operational inefficiencies to improve or significant potential upsides to benefit from, in both the short and long term.
- ii. Private equity buyers often replace existing management when they acquire a company, which disrupts the corporate equilibrium, affecting relationships with both internal and external stakeholders. Therefore, such changes lead to greater volatility and higher risk of default compared to the continuity established in MBOs.

Subsequently, going deeper on the comparison of individual score's components, this research analyzes each determinant of the Altman Z-Score. Despite a countertrend effect on operational profitability, with MBOs having a more negative impact compared to IBOs, the overall better effect of MBOs on corporate default risk is linked to RET/A and WC/A components.

5.2. Limitations and Suggestions for Future Research

As outlined by Romaniello, Dallochio, and Rodemeier (2024), the analysis focuses on a specific holding timeframe, notably the three-year period following the acquisition. This horizon is primarily chosen for two reasons. Firstly, as mentioned in Chapter 3, this timeframe has been extensively used since the early studies on leveraged buyouts (Kaplan, 1989) and subsequent academic literature (Munari, Cressy, & Malipiero, 2006; Boucly et al., 2011) to examine the effects of these transactions on the financial health of target companies. Thus, this analysis aimed to maintain consistency with academic studies that have investigated the same phenomenon from different perspectives. Second, extending the holding period by an additional two years would have significantly reduced the sample size, leading to potential issues related to data limitations.

On the other hand, it is important to note that the average holding period for IBOs in Europe is approximately 4.6 years (Jenkinson, Morkoetter, Schori & Wetzler, 2022). This discrepancy suggests that the evidence found may only partially reflect the value creation strategies of private equity firms. In other words, extending the comparison period could potentially yield different conclusions. When acquiring a target, private equity investors typically aim to improve governance structures and operational efficiency, which involves incurring immediate costs with the expectation that operational benefits will emerge over time. Therefore, although the three-year analysis timeframe generally captures the so-called inflection point⁵³, it risks overlooking the full realization phase of the investment. This perspective suggests that a more comprehensive evaluation of private equity strategies requires a broader timeframe, accurately reflecting the average holding period and allowing for a more complete assessment of the investment's lifecycle, from initial changes to the realization phase.

Additionally, methodologically, in comparing the effects of phenomena (“treatments”) on a specific sample, models such as difference-in-differences are often used. In this case, given the limited data available (28 MBO transactions and 64 IBO transactions), attempting to group such a small pool of companies in terms of similarities would result

⁵³ In this case, an inflection point is defined as the point in time when value begins to be created considerably relative to the upfront costs incurred.

in findings not supported by the necessary parallel trend assumptions required by these models.

Regarding suggestions for future research, this study aims to serve as a starting point for delving into a relatively understudied topic in the literature, namely the differences between MBOs and LBOs. Building on the study's findings, future research could analyze the effects when management and private equity become co-owners:

- i. Sometimes, private equity funds lend money to managers, effectively making them stakeholders in the company.
- ii. Other times, existing management is involved in ownership by the incoming private equity through structures such as management incentive plans.

Considering these interactions, future research could analyze how the effect on the risk of default changes based on the shareholders involved.

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