

PRIVATE EQUITY'S APPETITE FOR ENGINEERING

**INVESTIGATING THE PERFORMANCE EFFECTS OF PRIVATE
EQUITY OWNERSHIP DURING EXOGENOUS SHOCKS**

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Private Equity's Appetite for Engineering: Investigating the performance effects of private equity ownership during exogenous shocks

Abstract:

This paper examines the performance of European small and medium-sized enterprises (SMEs) backed by private equity (PE) firms compared to non-PE-backed counterparts during two consecutive, unrelated crises: the COVID-19 pandemic and the Ukraine war. Our findings reveal that PE-backed SMEs underperform in terms of profitability, although this divergence only occurs in 2022. We further analyze two key value drivers of PE portfolio companies' profitability: operational engineering and financial engineering. Over the course of the crises, PE-backed SMEs face challenges stemming from initial heavy financial engineering at the onset of the COVID-19 pandemic and exhibit signs of reduced operational efficiency. Combined, what should have created value for the companies, leads to reduced profitability short-term.

Keywords:

Private Equity, Performance, SME, COVID-19 Pandemic, Ukraine War

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1. Introduction:

The contribution of private equity (PE) ownership has been shown to improve performances of portfolio companies relative to non-PE backed firms during financial crises (Bernstein, Lerner, and Mezzanotti, 2019) and significant exogenous shocks such as COVID-19 (Wilson & Lavery, 2022). In this thesis paper, we aim to evaluate whether PE ownership is a source of increased value creation and resiliency among small- and medium-enterprises (SMEs) throughout two consecutive crises: the COVID-19 pandemic followed by the Ukraine war.

PE is a major and growing industry of today's economies. Globally, assets under management by PE-funds reached around \$8 trillion in 2023 (Aliaj, Learner, Arenas, Joiner, Louch, and Wiggins, 2024), while about 10.5 million people, or 5% of the total European workforce, were employed by PE-owned companies in 2019 (Invest Europe, 2024). The performance of PE firms and respective portfolio companies thus poses wider implications on the financial and economic stability of the EU. This is particularly true during times of economic turmoil.

The back-to-back shocks of the COVID-19 pandemic and the Ukraine war posed considerable stress tests to firms' adaptability to the changing macroeconomic, geopolitical, and sociological conditions. Strict lockdowns and travel restrictions across the European Economic Area (EEA) saw private consumption and average Gross Domestic Product face a sharp decline in 2020 (Eurostat, 2024). As the European economy appeared to recover from a second wave of COVID-19 cases and related restrictions in 2021, a Russian invasion of Ukraine broke out only a few months later, in February, 2022. Immediate sanctions, travel bans, and freezing of Russian held foreign assets evolved. Subsequent reprisals took place towards the EU, and natural gas trade, with Russia being by far the biggest provider to the EU, almost nullified. This halting of natural gas supply caused an energy crisis in the EU, contributing to historic inflation rates across the continent in 2022 and 2023 (Eurostat, 2024). As such, corrective measures were imposed to return inflation rates to the long-run target of 2%, with the ECB and central banks across the EEA's member states significantly increasing benchmark interest rates that year.

The three years, 2020 to the end of 2022, can thus be characterized as a 'cocktail' of challenges for European businesses. This holds particularly true among SMEs, defined by the EU as companies with fewer than 250 employees and either annual revenues of up to €50 million or total assets of up to €43 million. Companies in this bracket constitute 99% of all businesses in the EU (European Commission, 2024). Among the 27,645 companies owned by private equity in Europe in 2022, 20,349 were SMEs, employing nearly 950,000 people (Invest Europe, 2024). By their nature, SMEs tend to be more vulnerable during crises, as they typically have smaller liquidity buffers, less access to capital markets, and thus greater exposure to financial distress and liquidation risks (Kalemli-Ozcan, Gourinchas, Penciakova, and Sander 2020). Due to the sheer reach in economic size and employment, their performances during times of crisis become

particularly crucial to wider macro-economic stability. This therefore presents an interesting case as to whether PE ownership of these enterprises can act as a foundation for better resiliency through economic downturns.

PE's role in value creation has nonetheless been viewed with skepticism. This was particularly true to the 2008 financial crisis. Critics argue that PE's obsession in financing acquisitions with high debt relative to equity, so called Leveraged Buyouts (LBO), causes the overlevering of portfolio companies, thereby increasing their vulnerability to systemic shocks and defaults (Haque, 2023). Recent studies, however, challenge this perception. Bernstein et al. (2019) demonstrate that PE-backed firms outperformed non-PE-backed firms during the 2008 financial crisis through alleviating portfolio firms' financing constraints. Similarly, Lavery and Wilson (2022) found that PE-backed firms exhibited greater operational resilience during the COVID-19 pandemic. Research outside of crises also suggests PE-ownership provides a foundation for value creation (Boucly, Sraer, and Thesmar, 2011; Kaplan and Strömberg, 2009; Gompers, Kaplan, and Mukharlyamov, 2016), providing an alternative viewpoint to what is a common criticism to the industry.

Significant gaps in research, however, remain in modern literature, which we address in this study. First, existing research often focuses on regions with high PE activity and accessible data, such as the United States, the United Kingdom, and France (Bernstein et al., 2019; Lavery and Wilson, 2022; Boucly et al., 2011). Broader, significant economic areas, like the EEA, have meanwhile been overlooked. Created as an extension of the European Union's single market to include members of the European Free Trade Association, the EEA provides a diverse environment for examining the effects of PE-backing throughout 2020 and 2022. Secondly, the combined impacts of two consecutive unrelated crises – such as the COVID-19 pandemic and the invasion of Ukraine – on PE-backed SMEs has yet to be sufficiently explored. Together, these crises provide unique conditions to better evaluate the adaptability and resiliency of PE-backed SMEs. Lastly, research analysing the impact of PE-ownership in times of crises is skewed towards larger, mid-cap firms, thereby overlooking SMEs (Bernstein et al., 2019; Lavery and Wilson, 2022). Conversely, SMEs constitute 99% of all companies in the EU and are primary drivers of economic growth (Autio, Kenney, Mustar, Siegel, and Wright, 2014). These considerations, along with the contention regarding value creation from PE, bring forward a case yet to be answered. As such, we form our first research question:

RQ1: How did PE-backed SMEs perform compared to non-PE-backed SMEs upon the onset of the COVID-19 pandemic and the Ukraine war?

Prior research suggests that PE backing can mitigate firm vulnerability in times of crisis. PE firms provide two primary value drivers, financial engineering and operational engineering (Kaplan and Strömberg, 2009). With financial engineering and operational engineering, the

investment firms seek to increase performance, support growth, and improve efficiency among their portfolio companies. In consideration of these points and the mentioned research gaps, our second research question therefore addresses PE-firms' potential value drivers:

RQ2: Did operational and financial engineering comparatively improve the performances of PE-backed SMEs during the COVID-19 pandemic and the Ukraine war?

Through a matched Difference-in-Differences analysis, we present puzzling findings challenging prior research (Bernstein et al., 2019; Lavery and Wilson, 2022). Contrary to our hypothesis, results suggest that PE-ownership does not create additional value during periods of crisis. An extension into operational and financial engineering illustrates the complexity of the general argument that PE firms provide a foundation of value creation. While the use of financial engineering is greater among PE-backed SMEs throughout the overall crisis, these findings were driven by the extensive use of debt financing, in 2020, to alleviate liquidity constraints among portfolio firms. An overleveraging of firms upon the onset of COVID-19 left them more vulnerable to the oncoming Ukraine war, and unable to obtain further external financing when the macroeconomic environment faced its second downturn in 2022. PE-backed companies were also unable to take advantage of greater operational engineering by their investors, with smaller SMEs most negatively affected by this. The findings from a multiphase crisis period therefore imply that the previously found advantages of PE-ownership should be taken into reconsideration. What research finds to be value creating towards SMEs is also what leaves them more vulnerable to value destruction, thereby explaining the underperformance we find from PE-ownership.

2. Theoretical Framework and Literature Review

This chapter assesses prior literature on PE and its role in value creation, focusing on two primary engineering strategies, namely, operational and financial engineering. We touch upon criticisms and contrasting theories to these channels of growth to provide insights into the complexity of the impacts of PE-ownership on portfolio companies. Lastly, we discuss how we contribute to existing research by Bernstein et al. (2019) and Lavery and Wilson (2022).

2.1 Private Equity

PE refers to investment firms, generally listed as a partnership or limited liability, that acquire private as well as public companies with the goal of enhancing the companies' growth and performance. PE firms invest and acquire companies using an alternative form of capital investing, a leveraged buyout (LBO). The LBO refers to an acquisition with a financing structure split between debt and equity, with the former generally making up 60% to 90% of the financing and the latter generally between 10% to 40% (Kaplan and Strömberg, 2009). The investment firms form PE funds, run by general partners, which pool equity from institutional investors and

wealthy individuals. Debt is generally financed by banks, but more recently there has been a shift towards issuing loans to institutional investors. PE-funds traditionally invest in mature companies with an average investment horizon of 5.89 years, as of 2023 (Asif and Sabater, 2023). The investors aim to exit an investment when its enterprise value has increased, referred to as a ‘buy-and-build strategy’.

2.2 Value Creation from Private Equity

The general consensus is that PE-funds create additional value to portfolio companies. Research finds that target firms of LBOs in France exhibited increased performance four years post-transaction in terms of sales, assets, and employment growth at 12%, 12%, and 18% respectively (Boucly et al., 2011). This was particularly true for private-to-private transactions, in which the target company was previously privately owned. Contrary research challenges that, in the case of public-to-private transactions (where the prior legal status of the target firm was a publicly listed corporation), post LBO performance is not improved in portfolio companies. These findings have, however, been disputed, and research has shown even public ownership to be outperformed by PE-backing (Moon, 2006).

Overperformance of PE-backed companies is, to a degree, a reflection of selection capabilities of PE funds towards firms that would create operational and performance improvements regardless of a LBO finalization (Biesinger, Bircan, and Ljungqvist, 2023). Biesinger et al. (2023) claim that the effects of “treatment”, that is, the influence of ‘value creating’ activities by PE-firms, are overemphasized in regards to portfolio overperformance. Critics rather attribute this to previously mentioned selection capabilities as well as information asymmetries in acquisitions towards PE investors and their ability to take advantage of tax breaks, thereby increasing returns to investors. There is extensive research, however, finding that PE firms themselves support portfolio companies in driving value creation at the company-level (Boucly et al., 2011; Bernstein et al., 2019; Gompers et al., 2016; Kaplan and Strömberg, 2009). The question then remains: *how* do PE-firms create value?

Traditionally operating as active owners, PE firms are shown to implement value-creating change in portfolio companies through three primary channels: financial engineering, operational engineering, and governance engineering. Financial engineering refers to the accessing of liquidity through equity injections and debt financing, using leverage, and facilitating high-value exits. Operational engineering refers to a PE firm’s industry and operating expertise used to implement strategic plans including cost-cutting measures, productivity improvements, strategy alterations, and potential mergers or acquisitions. Governance engineering encompasses changes made within the senior management and board, and the recruitment of new management (Kaplan and Strömberg, 2009).

The extent of the influence on portfolio company performance from the three engineering methods is a topic widely under contention, particularly between financial and operational engineering. However, the use and utility of one of these methods does not imply a negligibility in the other two engineering methods, rather, they work together (Gompers et al., 2016). In this study, we focus on financial and operational engineering, as the two most debated means of value creation in portfolio firms.

2.2.1 Financial Engineering

Boucly et al. (2011) conducted a study on 839 LBO targets in France, focusing on changes in corporate behavior and the respective impact on PE portfolio company performances post-transaction. PE-firms were found to contribute to an easing of credit constraints faced by portfolio companies, particularly within vulnerable firms, thereby increasing their operational performances up to 4 years after the LBO. External financing was most prominent through debt contribution, and its effects are highly notable. One-third of the 12% increased growth in assets post-acquisition was attributable to the contribution of debt financing. The findings are supported by Ivashina and Kovner (2011) who highlight that PE firms, due to previous and consistent interactions with banks, are able to obtain more debt with more favorable credit terms. For example, PE-firms are more capable of refinancing debt and extending debt maturity to aid portfolio companies (Gompers, Kaplan, and Mukharlyamov 2022). These arguments rest on the theory that PE firms, due to better relationships with banks, reduce information asymmetry as to their creditworthiness and, thus, banks are willing to lend with better terms at greater amounts and lower interest rates to portfolio firms (Ivashina and Kovner, 2011).

PE firms also aid during liquidity constraints through providing equity injections (Bernstein et al., 2019; Lavery and Wilson, 2022). One primary source of this is from “dry-powder”, cash committed by investors but yet to be allocated to a specified investment. The funding structure of pooled investor capital allows PE companies to intervene when a portfolio company faces liquidity distress (Bernstein et al., 2019). PE-firms continuously aid with equity injections throughout the years post-LBO. Around 66% of PE funds do so within the 1st year and 78% over the first three years (Cohn, Hotchkiss, and Towery, 2022).

Contrary to these findings, Biesinger et al. (2023) reject the hypothesis that financial engineering, measured in their case through both leverage and debt to EBITDA, provides value creation to portfolio companies. The scope of defining metrics for financial engineering here appears rather limited in its wider application, as the researchers solely focus on the debt financing side. As research indicates, equity injections also have an impact of significance in value creation. Where the prior PE model of high leverage during the 1980s may have partly diminished, PE firms still contribute to portfolio companies through increasing equity financing in conjunction with debt financing (Bernstein et al., 2019; Boucly et al., 2011; Lavery and Wilson, 2022).

2.2.2 Operational Engineering

PE firms are additionally found to contribute to operational improvements within their portfolio companies. Private-to-private transaction overperformance can, in part, be explained by target firms lacking the necessary expertise to increase growth and enhance operational performance. PE-firms bridge this gap by providing consultation and intervention services. While the areas of improvements vary, PE funds mostly maintain a focus on cost-reduction and revenue increasing mechanisms as well as business model and strategy alterations (Gompers et al., 2016), though this varies with the fund. Such value creation has been particularly useful for operationally weak firms, targets presenting potential turn-around cases for PE-funds, an ever growing characteristic of modern PE transactions.

Although Biesinger et al. (2023) maintain skepticism towards the wider significance of “treatment” effects by PE-funds for portfolio companies, the study finds that investments through capital expenditures (CAPEX), as the sole form of operational engineering, has a positive effect on value creation. CAPEX, they argue, provides a channel for firms to invest into profitable projects and divest from unprofitable ones. Boucly et al. (2011) further present results that CAPEX investments within PE-backed firms increased greatly comparative to a control group at 24% four years after the LBO. This comes in combination with the improved metrics in sales, assets, and employment growth which the study also found four years post-LBO. Both studies indicate a heavy use of operational engineering through investments by PE firms towards their respective portfolio companies.

2.3 Private Equity Portfolio Performance and Engineering during Crises

Although PE is criticized for overlevering portfolio companies and leaving them vulnerable to default during times of crisis, multiple studies find that PE firms perform comparatively better when the economy is under distress. In a survey conducted across 200 PE fund managers regarding the impacts of the COVID-19 pandemic, 50.8% of PE portfolio companies were reportedly unaffected in terms of performance, with the majority of time spent by PE staff allocated towards assisting current holdings rather than working on new deals (Gompers et al., 2022).

Bernstein et al. (2019) conducted a study on the impact of the 2008 financial crisis on PE-backed firms in the UK compared to a control group. More specifically, the researchers sought to find whether PE firms help alleviate capital constraints in portfolio companies through increasing access to debt and equity financing, thereby increasing investments and the performances of the respective companies. A matched DiD analysis suggested that PE portfolio firms outperform in terms of profitability, compared to non-PE-backed companies. The difference in performance is attributed to higher investment levels sourced from the ability to

obtain greater debt and equity contributions. Equity injections were largely reasoned by PE-firms' dry-powder, often used as a back-up financing method during financial distress.

Lavery and Wilson (2022) conducted an extending research paper to Bernstein et al. (2019), with a focus on the impact of the COVID-19 pandemic on PE-backed firms in the UK compared to a control group. The study centralized on firm performance measured by earnings, sales, employee, and asset growth, with follow-up analyses on operational and financial engineering. The researchers concluded PE-backed firms were observed to outperform a control group during the crisis period. Financial engineering through debt and equity financing provided a significant source of value creation here, whereas operational engineering had no notable effect on outperformance of PE-backed firms.

2.4 Private Equity Ownership of Small and Medium-Sized Enterprises

Traditionally, mid-cap corporations, with an employee count above 250 and below 1500, are the most transacted size-category by PE, accounting for two-thirds of total deal value (Hancock, 2023). A recent shift, however, has been trending towards SME private equity and micro-cap private equity. These differ from venture capital, in that buyouts remain in use, where acquisitions of majority stakes are made in more mature companies. Concerns regarding performances of PE portfolios weighted more towards SME ownership have arisen. This is argued to be a result of PE fund employees, becoming spread too thinly, meaning each employee oversees multiple portfolio companies. A higher quantity of smaller portfolio companies in a PE fund implies more staff assigned to less valuable investments, hampering economies of scale in operations (Humpfrey-Jenner, 2011). Cumming, Fleming, and Suchard (2005) argue this holds implications for small enterprises in which value creation is largely driven by the operational expertise and consulting from the PE fund managers and staff.

2.5 Extension to Prior Research:

The focus on the EEA, while not novel, is an often understudied area within the PE industry. This becomes particularly true when compared to the United States and the United Kingdom, despite the EU, the primary component of the EEA, being the second biggest private equity market by target deal valuations (Statista, 2023). The EEA presents an interesting case due to its effectual proximity to both crises, felt through near continent-wide lockdowns to immediate sanctions in 2022 on its biggest natural gas provider. It additionally provides a diverse environment for the study due to variations among nations in their responses to the COVID-19 pandemic and in their reliances on Russian natural gas and trade pre-Ukraine war. In this light, we argue that findings from a more diverse sample provides greater applicability to the general PE industry globally, compared to one-country studies such as those conducted on the US and the UK. Additionally, while our time-period is similar to that of Lavery and Wilson (2022), we extend their study by adding an additional year, 2022, to include the analysis of the repercussions

of the Ukraine war in addition to lagged effects of the COVID-19 pandemic. This provides a lengthened, more comprehensive case to determine whether PE-backed SMEs are truly more resilient throughout prolonged periods of volatility and uncertainty. Furthermore, the COVID-19 pandemic, as argued by Lavery and Wilson (2022), and the Ukraine war are best characterized as unpredictable exogenous shocks. This is in comparison to the 2008 financial crisis, studied by Bernstein et al. (2019). Although the financial crisis too categorizes as an exogenous shock, it is defined by a buildup of unstable leverage in credit markets, which acts as a major predictor for upcoming recessions (Greenwood, Hanson, Shleifer, and Sørensen, 2021). Predictability is the differentiator here, and the lack thereof provides us with a valid stress test on PE owners, who, in this case, are unable to use any preemptive measures to prepare for either of the upcoming crisis.

We study solely firms matching the SME criteria pre-crisis, in 2019, as opposed to prior research which implements no such restrictive size range. Bernstein et al. (2019) make an explicit exclusion of small-sized firms in their data sample, forming a clear gap in the research that we aim to fill. SMEs were comparatively the hardest hit size-category of firms during both the COVID-19 pandemic and the Ukraine war. Furthermore, the said competitive disadvantages of owning SMEs (Humpfrey-Jenner, 2005) as compared to holding larger mid- to large-cap corporations present a potentially alternative hypothesis to the findings of over-performance among PE-backed firms during the 2008 financial crisis and the COVID-19 pandemic. We also narrow the scope of our analysis, compared to Bernstein et al. (2019) and Lavery and Wilson (2022), by focusing on PE-backed SMEs that underwent a private-to-private transaction to reach their current PE ownership profile. In turn, we compare PE-backed firms' performances to non-PE-backed private enterprises. Prior research strongly supports over-performance of PE-backed SMEs particularly in the case of these transactions (Boucly et al., 2011), but there remains a gap in studies towards such transaction groups during times of exogenous shocks.

3. Hypotheses:

H1: PE-backed SMEs operationally perform better short-term than non-PE-backed SMEs following exogenous shocks

This hypothesis catches the value creation component from PE-ownership. We believe PE-backed firms will prove more resilient in the face of the COVID-19 pandemic and Ukraine war, considering the value-creating benefits of PE ownership (Bernstein et al., 2019; Lavery and Wilson, 2022; Gompers et al., 2022; Boucly et al., 2011). Despite concerns on PE firms' ability to add value to smaller portfolio companies, we hypothesize that the general benefits of PE-ownership from additional financial engineering and operational engineering outweigh this alternative hypothesis. Particularly, in light of the extended crisis period, we believe these differences will become more clear. We hypothesise that PE-firms allow for better access to

external financing and adaptation through multi-phase crises due to the synergies arising from PE-owners' expertise in resource management and operational efficiency.

H2: PE-backed SMEs use more financial engineering than non-PE-backed SMEs following exogenous shocks

We hypothesize that PE-backed SMEs use more financial engineering mechanisms through increased debt and equity injections, compared to non-PE-backed SMEs following the COVID-19 pandemic and Ukraine war. Given the value-creation benefits of PE ownership in times of crisis (Bernstein et al., 2019; Lavery and Wilson, 2022; Boucly et al., 2011; Ivashina and Kovner, 2011), we believe that PE firms' established credit relationships and dry powder provide an advantage in navigating exogenous shocks. While critics argue that financial engineering's value creation may be overstated, particularly in the context of smaller firms (Biesinger et al., 2023), we believe that the broader scope of PE-backed financial interventions – combining greater debt financing and equity support – is upheld for smaller companies during extended crises.

H3: PE-backed SMEs use more operational engineering than non-PE-backed SMEs following exogenous shocks

Our final hypothesis aligns with Gompers et al. (2016), suggesting that financial and operational engineering in companies with PE ownership are not mutually exclusive. Operational engineering, as evidenced by Boucly et al. (2011), includes targeted measures such as cost management, revenue optimization, and CAPEX. Their findings highlight the efficiency of PE-firms in directing resources to profitable ventures while divesting from less productive ones. We believe such operational interventions to create additional value for PE-backed SMEs during the crisis period.

4. Methodology

Our methodology follows that of Bernstein et al. (2019), with minor incorporations from Lavery and Wilson (2022) and Boucly et al. (2011).

4.1 Data Collection:

To collect the sample of PE-backed firms, we use CapitalIQ provided by S&P Global to filter for all PE-backed transactions of SMEs, within the EU and EFTA, between 2010 and 2019. As 2020 was the start of the pandemic, we filter for firms which had been bought preceding this crisis, thus 2019 is the last year for transactions. Keywords are used to find transactions specifically backed by PE firms, specifically “Leveraged Buyout”, “Management Buyout”, “Platform”, and “Going Private Transaction.”

Transactions followed by an investment exit by the PE firm are also filtered out to prevent the inclusion of any firms that may have been sold to a non-PE parent company. While Bernstein et al. (2019) and Lavery and Wilson (2022) include investment exits following their crisis periods, we opt not to include investment exits. This is due to our crisis period being defined as between 2020 to 2022, where the latter year is the last available year for sufficient financial data for all sampled companies in Orbis. This exclusion of investment exits is done through an investment exit filter on CapitalIQ and manually in excel, to ensure incorrect data is removed.

Once PE-backed transactions are collected from CapitalIQ, a total sample of 9994 PE-backed firms are left. These company names are added into the Orbis platform, a Moody's Corporation publication providing company data from across the globe. Only firms with exact name matches in Orbis are kept to prevent any risks of incorrect firms added in our PE-backed or control company sample. We filter for firms which have financial data required for a control group matching process, explained in section 4.2, and enterprises lacking such data are removed from the sample. Furthermore, we filter for firm size in 2019 to form an SME sample, where a firm's employee count must be below 250 and revenue at or below €50 million or an asset value at or below €43 million. This leaves us with a reduced sample of 981 PE-backed firms.

4.2 Finding a Matched Control Group

As this is a study comparing two samples of enterprises, we further create a control group. This is done through a propensity score matching procedure with each PE-backed SME, based on observable variables in 2019, the year before the defined crisis period. The end result is a one-to-one match between a control company and a PE owned firm. We start by selecting potential control companies in the Orbis data platform which match the SME criteria in 2019. We continue by following the methodology and variable selection of Bernstein et al. (2019) and

filter out for firms in the Orbis platform with the same two-digit SIC code for industry, total assets within a 50% range of the PE-backed firm, net income divided by assets within a 50% range of the PE-backed firm, and solvency (equity divided by assets) within a 50% range of the PE-backed firm. Solvency was chosen due to better data coverage on Orbis, and illustrates the same concept as leverage, used by Bernstein et al. (2019), but is the inverted equivalent and measures the ratio of equity to assets of a firm. An initial choice of the 50% range for total assets, net income divided by assets, and solvency is in line with Boucly et al. (2006).

We also control for geographical location by matching the nation of headquarters of the control and PE-backed company in 2019. This is necessary to remove any effects arising from primarily alternate reporting requirements, impacts from local legislation, and general economic discrepancies during the 2020 to 2023 time period. We add an additional filter for the date of incorporation, not used by Bernstein et al. (2019). Companies formed after 2000 are matched within a range of 365 days due to concerns regarding survivorship bias. This is applicable due to the relative recency of the 2008 financial crisis. We argue firms founded pre-financial crisis has more likely learnt how to adapt operationally and financially to crises, compared to a firm founded around the booming economy leading up to the COVID-19 pandemic. Companies founded before 2000 are not matched based on date of foundation, as we do not deem survivorship bias to be a concern for these firms

Lastly, we identify, out of all control companies which match the specified criteria for each PE SME, the firm with the lowest propensity score. We replugin all matched companies into Orbis to collect additional data on variables to be analysed in this paper, as described in section 4.3. A few firms lack all data outside of 2019, and as such, these firms and their matches are excluded from the study. For firms missing certain financial data between two years, we use imputation to fill these gaps. We retest the propensity score matching for the final list of matches, and finalize the process with a one-to-one match for each PE-backed SME. We conduct robustness checks through a Welch's T-test, testing the mean differences across the treatment and control group variables. Results indicate that the difference in the 2019 solvency ratio value between the treatment group (PE-backed SMEs) and the control group, is statistically significant. We therefore constrict the range for solvency by a further 5%, down to 45%, to remove statistical significance in the mean difference of the treatment and control groups' solvency. The final sample consists of 421 PE-backed SMEs and 421 non-PE-backed SMEs, bringing the total number of sample units to 842.

Despite maintaining less rigorous ranges for the financial criteria, our final PE-backed sample size remains barely larger than that of Bernstein et al. (2019) and a little bit more than half of that of Lavery and Wilson (2022). We attribute this to the restrictive size criteria used to study SMEs, discrepancies in data availability among EU and EFTA nations compared to the UK, and the addition of matching on the date of a company's incorporation.

Panel A and panel C of Table 1 show the distribution of firms across industries and countries respectively. Firstly, large portions of the sample are represented by the services and manufacturing industries, the two largest within the EU respectively. The table presents potential industry preferences of PE investors towards manufacturing, despite the services industry being larger. Furthermore, there appears to be an underrepresentation of German SMEs and overrepresentation of nations such as Finland, Norway, and Sweden, based on merger and acquisition (M&A) activity from 2010 up to 2019 (Statista, 2023). The average firm in our final PE-backed sample had an operating revenue of approximately €12.3 million. This highlights the alternate focus on the SME population in our study compared to Bernstein et al. (2019), where the average firm in 2007, pre-crisis, was a mid-cap company with a revenue figure of USD 80 million, equivalent to roughly USD 98 million, or €87 million, in 2019 (Federal Reserve Bank of Minneapolis, 2024). As seen in panel B, most firms are classified as medium sized-enterprises, although toward the smaller end of this category. In Panel D, we see that no differences among the treatment and control group are statistically significant, implying a robust matching procedure for the sample. To note, both revenue and assets, initially in a thousand euro format, are taken in their log value to prevent skewness arising from larger firms.

Table 1. Summary Statistics

Panel A: Industry Distribution

Industry	Count	(%)
Agriculture	1	0.2%
Construction	30	7.1%
Manufacturing	177	42.0%
Retail Trade	11	2.6%
Services	119	28.3%
Transportation, Communications, Electric, Gas, and Sanitary Services	12	2.9%
Wholesale Trade	71	16.9%
Total	421	100%

Panel A reports the distribution of broad industries based on the 1-digit SIC code for the PE-sample. Due to one-on-one matching, the same distribution applies for the control group. We exclude the industries financial, insurance, regulated, and public administration firms from our sample.

Panel B: Size Distribution

Enterprise Category	Employees		Revenue		Total Assets	Firm Count
Micro	< 10		≤ €2 million		≤ €2 million	42
Small	< 50	And	≤ €10 million	Or	≤ €10 million	128
Medium	< 250		≤ €50 million		≤ €43 million	251

Panel B reports the distribution of firm-size categories based on the criteria noted by employees, revenue, and total assets. There are three categories which make up SMEs: micro, small, and medium-sized firms.

Panel C: Country Distribution

Country	Count	(%)
Austria	1	0.2%
Belgium	6	1.4%
Cyprus	1	0.2%
Czech Republic	7	1.7%
Denmark	3	0.7%
Estonia	3	0.7%
Finland	28	6.7%
France	109	25.9%
Germany	18	4.3%
Greece	2	0.5%
Hungary	4	1.0%
Ireland	3	0.7%
Italy	84	20.0%
Latvia	2	0.5%
Lithuania	2	0.5%
Netherlands	4	1.0%
Norway	15	3.6%
Poland	4	1.0%
Portugal	6	1.4%
Romania	3	0.7%
Slovakia	5	1.2%
Slovenia	1	0.2%
Spain	62	14.7%
Sweden	48	11.4%
Total	421	100%

Panel C reports the distribution of firms across their country of headquarter prior to the PE-backed acquisition. The middle column reports the absolute number of firms, while the right column reports a country's percentage representation of the total sample. Due to one-on-one matching, the same distribution applies for the control group.

Panel D: Firms' Characteristics in 2019

	PE-Backed SMEs				Control SMEs				Mean diff.	P-Value
	N	Mean	Median	SD	N	Mean	Median	SD		
Revenue (log)	420	8.96	9.24	1.33	421	9.01	9.10	1.30	-0.05	0.55
Total Assets (log)	421	8.70	8.93	1.37	421	8.75	8.92	1.35	-0.04	0.64
Profit Margin	420	0.07	0.05	0.11	421	0.08	0.05	0.12	-0.01	0.36
EBITDA/Assets	413	0.15	0.14	0.13	410	0.16	0.13	0.14	0.00	0.63
Net Income/Assets	421	0.09	0.08	0.11	421	0.10	0.08	0.11	0.00	0.62
Solvency	421	0.46	0.46	0.21	421	0.48	0.48	0.22	-0.02	0.16
Debt Contribution/Assets	419	0.01	0.00	0.17	419	0.02	0.01	0.15	-0.01	0.37
Equity Contribution/Assets	419	-0.07	-0.02	0.13	419	-0.06	-0.02	0.12	-0.01	0.56
Cost of Liabilities	409	0.02	0.01	0.02	407	0.01	0.01	0.02	0.00	0.21
Investments/Assets	405	0.07	0.08	0.18	404	0.08	0.09	0.18	-0.01	0.67
Operating Expenses/ Revenue	412	0.89	0.91	0.11	410	0.88	0.90	0.12	0.01	0.33
Working Capital/Assets	421	0.29	0.28	0.24	421	0.30	0.29	0.26	-0.01	0.55

Panel D reports the mean and median values of each variable across PE-backed SMEs and the control SMEs. "Mean diff." measures the difference between the mean values of PE-backed and Control SMEs, with P-Values measuring the respective statistical significance. Values are winsorized at the 2% level to remove any influences from outliers.

4.3 Dependent Variables:

As the study is divided into three analyses, we form three groups of variables from those listed in panel D of Table 1. We first select variables to measure firm performances, used to determine whether there is any outperformance, or value creation, from PE-ownership of SMEs. We capture this component through analyzing developments in firm profitability, sales, and assets. We take inspiration from Lavery and Wilson (2022), collecting data on total assets, as a measure of firm size growth, earnings, defined as earnings before interest, taxes, depreciation, and amortization (EBITDA) and revenue, defined as operating revenue. We take the logarithmic value of both revenue and assets to handle skewness of data towards developments in variable values of larger firms. As such, all changes in the log of revenue and assets in our tables indicate percentage changes. We further include net income as additional measure of earnings, normalized by assets, and profit margin, measured as net income divided by sales. Adding these variables addresses any concerns of EBITDA measures overstating firm profitability by providing a bottom-line view, accounting for all expenses including non-operating items.

The second analysis refers to the use of operational engineering. While measuring a PE-funds operational expertise and consultation services is difficult, we do select variables which track a firm's ability to use operational engineering. This is done, firstly, through measuring cost efficiency, measured as operating expenses less depreciation and amortization divided by sales. This is based on the cost reduction measure used by Boucly et al. (2011), but adapted to data limitations in Orbis, and shows the extent to which firms can effectivize and minimize operational costs during the exogenous shocks. For simplicity purposes, we call the cost metric “operating expenses”, although it is important to note it leaves out depreciation and amortization expenses, as per our mentioned calculation for the variable. Additionally, working capital as a percentage of total assets is analyzed (Boucly et al., 2011). Working capital (WC) is calculated as current assets minus current liabilities. The choice of using current liabilities rather than current non-interest bearing liabilities comes down to data availability in Orbis of the latter variable. WC is an indication of a firm’s operating liquidity and helps describe an SME’s ability to fund current operations and buffer against any short-term financial scarring. Investments, defined as change in assets plus depreciation and amortization (Bernstein et al., 2019), is also analyzed. This catches the extent to which firms work to invest into growth initiatives. To define whether PE-backed SMEs make more use of financial engineering, we use debt contribution, defined as the change in liabilities, and equity contribution, defined as the change in equity minus net profit. These variables help provide an understanding as to whether PE-firms ease financing constraints in portfolio companies through improved access to external financing. Solvency is also used to determine the extent to which PE-backed firms alter their capital structure. These variables and definitions are inspired by Bernstein et al. (2019). We normalize investments, debt contribution, and equity contribution to assets to account for varying firm size.

4.4 Control Variables:

To strengthen our analysis and reduce potential for omitted variable biases, we augment our model with three control variables. The omitted variable bias refers to the absence of relevant variables which affect the dependent variables. This leaves a statistical model vulnerable to overemphasizing any effects of variables included in the model. The inclusion of control variables thus further isolates the effect of PE-backing during the crisis. All control variables are set at their 2019 values to establish a pre-crisis baseline. In the augmented model we control for company size, performance, and financial health, inspired by Lavery and Wilson (2022).

Size: Existing research suggests that larger firms are more resilient in times of exogenous shocks (Bernstein et al., 2022). The intuition is that a larger balance sheet value coincides with greater liquidities. Furthermore, a greater balance sheet value posts more collateral that can be sold off in face of financial distress or used for refinancing. We define firm size as the logarithmic value of total assets before the onset of the crisis.

Performance: Companies with greater profitability tend to have a stronger cash flow, providing a cushion to absorb unexpected declines in revenue or increases in costs. Pre-crisis profitability can therefore influence firm performance throughout the crisis period. We define firm performance as EBITDA normalized by assets, as EBITDA is less impacted by firm and country specific accounting standards and therefore more indicative of a company's true performance.

Financial health: Companies with greater levels of debt should be more likely to face liquidity distresses when market conditions become less favorable. Solvency thus serves to control a company's financial health before the crisis.

Before finalizing the augmented model, we ensure that our control variables are not highly correlated with each other to minimize the risk of multicollinearity. Multicollinearity arises when control variables are strongly correlated, making it difficult to estimate their individual effects on the dependent variable and potentially leading to inflated standard errors, unstable coefficients, and reduced reliability of the model's results. Additionally, we assess the correlation between the control variables and the treatment effect, PE-backing, to rule out potential confounding effects. Confounding implies that a control variable not only affects the dependent variable but is also a sought-after characteristic for PE firms when selecting portfolio companies. The second correlation test thus rules out potentially selection biases.

4.5 Empirical Strategy:

For the initial comparative analysis, we perform a matched DiD fixed effect model on a panel data set, as a replication of Bernstein et al. (2019). We study the performance and use of operational engineering and financial engineering of PE-backed SMEs during the years 2017 to 2022. 2020 and onwards is defined as the crisis period upon the onset of COVID-19, after which it continues in 2022 upon the onset of the Ukraine war. This is in line with the first reported COVID-19 case in the EU in January, 2020, and upon the invasion of Ukraine in February, 2022. We form our following regression formula for the study:

$$(1) y_{it} = \alpha_t + \alpha_i + \beta_1(\text{PE SME}_t \times \text{Crisis}) + \theta X_{it} + \varepsilon_{it}$$

In the estimated formula, y_{it} represents the dependent variable for firm i at time t , which are the performance, operational engineering, and financial engineering variables. On the right hand side, we include year (α_t) and firm (α_i) fixed effects. Firm fixed effects account for time-invariant discrepancies between all firms in the sample while year fixed effects allow us to control for unobserved factors which are constant across the sample, but vary over time. We include a treatment dummy variable (PE SME_t) for whether an SME is PE-backed (1) or not (0) and Crisis, a dummy variable with the value 1 for the period 2020 to 2022 and 0 for the pre-crisis period. An interaction term is used between the dummy variables and coupled with the coefficient term (β_1) which helps us determine the effects of PE-backing during the crisis on the dependent variable. This interaction term is therefore an independent variable and the coefficient represents the magnitude of its effect. In this model, we group the two crises into one dummy variable, primarily due to the lagged effects that SMEs endure from the COVID-19 crisis into the onset of the Ukraine war (Brooks and Orzag, 2023). This spill over and potential unobserved lagged effects of the first crisis make it difficult to accurately isolate the effects of the two crises. We further include control variables (θX_{it}), previously mentioned variables from section 4.4, which isolate the effects of the interaction term, as well as account for an error term (ε_{it}) in the model. Our regression uses a panel linear model (PLM) rather than the linear model (LM) used by Bernstein et al. (2019) and Lavery and Wilson (2022). This is due to the PLM being better adapted to panel data and handling unobserved heterogeneity among firms, thereby accounting for both firm-fixed effects and time-fixed effects.

In addition to our primary model from equation 1, we add an additional year-by-year DiD model to provide more detailed insights into yearly performances during the crisis of PE-backed SMEs, compared to a control group. The crisis period is undoubtedly bipolar in terms of the macro-effects, that is, lockdowns in 2020, demand recovery and regulation easing for COVID-19 restrictions in 2021, and rapid inflation in 2022. Performances are thus likely to vary on a year-by-year basis and, as such, we pinpoint the interaction term between the PE-backing and the

crisis to each specific year. Exhibits A1 to A12 in the appendix support this, where changes in value differences of variables between the treatment and control group differ greatly, as seen in, for example, investments and debt contribution. We therefore add a similar model to equation 1, through three separate equations 2, 3, and 4, where the sole difference is the splitting of the crisis dummy variable into the years 2020, 2021, and 2022. This provides better insight into the year-by-year resilience of PE-backed SMEs in addition to their behaviours in terms of operation and financial engineering. The main model for the analysis and testing of the hypothesis, however, remains equation 1, as we seek to analyse the overall effect of PE-ownership during both the COVID-19 pandemic and the Ukraine war. With that noted, we estimate the following formulas for the year-by-year DiD regression:

$$(2) y_{it} = \alpha_t + \alpha_i + \beta_1(\text{PE SME}_t \times 2020) + \theta X_{it} + \varepsilon_{it}$$

$$(3) y_{it} = \alpha_t + \alpha_i + \beta_1(\text{PE SME}_t \times 2021) + \theta X_{it} + \varepsilon_{it}$$

$$(4) y_{it} = \alpha_t + \alpha_i + \beta_1(\text{PE SME}_t \times 2022) + \theta X_{it} + \varepsilon_{it}$$

4.6 Welch's T-Test:

To be able to interpret a causal relationship in our DiD analysis, the Parallel Trends Assumption must be met. This states that the difference in values between the dependent variable of the PE-backed SMEs and control SMEs remain constant over time in the case that no crisis takes place. That is, we assume their development/growth rates to be equal or similar had there been no crisis. To test this assumption, we diverge from the methodology of Bernstein et al. (2019) and conduct two Welch's t-tests on the mean trends of firm characteristics. This is done for both one year (2018 to 2019) and two year (2017 to 2019) pre-crisis trends of the defined performance, operational engineering, and financial engineering variables. The Welch's t-test compares the mean values of the variables' trends across the treatment and control groups to determine whether any statistically significant differences arise. It is an especially robust approach to testing the Parallel Trends as it can account for unequal variances between PE-backed and non-PE-backed firms, and performs well with unequal sample sizes, as is the case for the data in this study.

Results are presented in Table 2, showing the number of observations, mean, median and standard error values for both groups, and lastly the mean differences accompanied by the p-value. If the mean trend differences are not statistically significant, measured through the p-value, we assume parallel trends. We remain more conservative in this assumption and identify p-values of 0.1, implying weak significance, as statistically significant for the Welch's t-test. This is due to the social science-like nature of our crisis periods, a field in which confidence levels above the 90% level, rather than 95% (p-value of 0.05), are more commonly used. We include only variables without statistically significant differences as dependent variables in our final DiD

regression. Interestingly, we see a large divergence among mean and median values of certain variables. Most notably, equity contribution, normalized to assets, presents a very high growth rate in the 1- and 2-year trends. This is likely due to base values for certain firms upon which growth is measured being near zero, thereby inflating the measured figure. The same issue arises for cost of liabilities and debt contribution. Nonetheless, all variables match the parallel trends assumption in both years as no mean differences are statistically significant. As such, we include all named variables in the DiD regressions.

Table 2. Firms' One and Two Year Trends in 2019

	PE-Backed SMEs				Control SMEs				Mean diff.	P-Value
	N	Mean	Median	SD	N	Mean	Median	SD		
<i>1-year trend</i>										
Revenue (log)	419	0.00	0.00	0.04	421	0.01	0.00	0.03	-0.00	0.269
Profit Margin	419	0.77	-0.09	8.54	421	-0.23	0.00	10.82	1.00	0.138
EBITDA/Assets	412	-0.36	-0.04	9.27	410	1.00	0.00	22.78	-1.37	0.261
Net Income/Assets	420	0.77	-0.12	9.02	421	-0.13	-0.00	10.74	0.90	0.188
Assets (log)	420	0.01	0.00	0.03	421	0.01	0.00	0.03	-0.00	0.268
Solvency	420	0.14	0.02	0.82	421	0.09	0.02	0.43	0.05	0.320
Debt Contribution/Assets	418	-0.25	-0.96	12.28	419	-0.61	-1.04	16.76	0.37	0.719
Equity Contribution/Assets	322	-17.42	-0.21	437.88	323	-2.51	-0.14	77.51	-14.91	0.548
Cost of Liabilities	385	94.55	-0.01	1718.03	387	1.80	-0.02	16.75	92.75	0.290
Investments/Assets	404	-1.67	-0.56	17.09	404	-16.56	-0.46	238.42	14.89	0.211
Operating Expenses/Revenue	411	0.01	0.00	0.10	410	0.00	0.00	0.07	0.01	0.230
Working Capital/Assets	420	0.06	0.00	6.12	421	0.21	0.00	4.97	-0.15	0.690
<i>2-year trend</i>										
Revenue (log)	419	0.01	0.01	0.06	421	0.01	0.01	0.04	-0.00	0.832
Profit Margin	418	-0.27	-0.06	10.66	421	0.32	0.00	68.73	-0.59	0.862
EBITDA/Assets	412	0.62	-0.05	14.74	410	0.06	-0.01	3.40	0.57	0.447
Net Income/Assets	418	-0.11	-0.11	10.63	421	-0.02	-0.04	72.49	-0.08	0.982
Assets (log)	420	0.02	0.01	0.06	421	0.02	0.01	0.06	-0.00	0.622
Solvency	420	0.26	0.03	1.28	421	0.19	0.02	1.19	0.07	0.384
Debt Contribution/Assets	418	-1.44	-0.93	23.99	419	-0.68	-0.84	15.81	-0.77	0.586
Equity Contribution/Assets	312	170.02	-0.30	2915.43	306	-40.16	-0.21	1739.08	210.18	0.276
Cost of Liabilities	387	6.51	-0.07	61.58	384	53.78	-0.12	709.89	-47.27	0.194
Investments/Assets	404	-0.04	-0.58	56.14	404	0.02	-0.37	7.37	-0.06	0.982
Operating Expenses/Revenue	411	0.01	0.00	0.11	410	0.00	0.00	0.10	0.00	0.569
Working Capital/Assets	418	2.89	0.00	33.41	421	0.55	0.00	16.37	2.34	0.199

Table 2. reports the 1-year and 2-year trends, between 2018 to 2019 and 2017 to 2019 respectively, across all variables for the PE-backed SMEs and non-PE-backed SMEs. Mean, median, and standard deviation (SD) values are reported for both the treatment and the control group. Number of observations (N) is provided to the left for each sample group. Mean differences in trends and the respective p-value are provided to indicate statistical significance. Trends are winsorized to the 2% level to remove any influences from outliers. Dashed lines separate the three groups of variables, presented in the order of performance metrics, financial engineering variables, and finally operational engineering variables.

5. Results:

We split our findings into three separate sections, as per the structure of the analysis: performance metrics, operational engineering, and financial engineering. In tables 3, 4, and 5, we report coefficients for the interaction term “PE SME $\times$ Crisis” in the top row coupled with standard error terms in parentheses below. Panel A of Table 3 presents findings for equation 1 for all performance metrics during the COVID-19 pandemic and the Ukraine war, as one crisis. For tables 4 and 5, the coefficients indicate whether PE-backed SMEs made more use of operational engineering and financial engineering than the control group, as a result of the onset of the crisis period. We couple the tables for the conjuncted crisis period with results from the year-by-year DiD regressions across 2020, 2021, and 2022 in panel B. Odd-numbered columns in the tables indicate coefficients without the inclusion of control variables, while even-numbered columns are models augmented with control variables. We trust these augmented regressions more than base regressions as the control variables reduce risks of omitted variable bias.

5.1 Performance Metrics

Before analyzing the DiD regressions, it is vital to note that both PE-backed SMEs and the control group handled the crisis period relatively well. Both samples saw increases in revenues and asset values by 2022 from pre-crisis values in 2019, as shown in exhibits 1 and 2 in the appendix. The results in Table 3 are, regardless, surprising. Profit margin, net income, and EBITDA were all negatively affected by PE-ownership during the COVID-19 pandemic and Ukraine war. When including control variables, PE-backed SMEs faced a 2.4% larger reduction in profit margins and a 1.8% and 1.7% decrease in net income and EBITDA respectively compared to the control group. These results, and those in columns 5, 7, and 9, all display statistical significance with a 99% confidence level. Meanwhile, both revenue and assets have positive coefficients, although these results are statistically insignificant both in the base model and the augmented model. We therefore conclude that there is no overall impact of PE-ownership on revenues and asset development throughout the COVID-19 pandemic and the Ukraine war. Since revenues throughout the crisis period do not change between PE-backed SMEs and the control group, but profitability measures do, we assume that PE-backed firms have been hit harder in terms of expenses during the crisis period. We investigate this further in section 5.3. A decline in profitability coupled with no change in asset size between the treatment and control group further implies that total asset size among PE-backed SMEs stems from external financing, rather than organic growth. This is analyzed in section 5.2.

Table 3. DiD Regressions on Performance Metrics

<i>Panel A: Crisis Period</i>										
	(1)	(2)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Revenue (log)		Profit Margin		Net Income/Assets		EBITDA/Assets		Assets (log)	
PE SME $\times$ Crisis	0.006 (0.016)	0.008 (0.016)	-0.022*** (0.004)	-0.024*** (0.004)	-0.018*** (0.004)	-0.018*** (0.004)	-0.015*** (0.004)	-0.017*** (0.004)	0.016 (0.016)	0.014 (0.016)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	5042	4928	5042	4928	5047	4933	4939	4933	5047	4933
P-Value	0.691	0.607	0.000	0.000	0.000	0.000	0.000	0.000	0.315	0.377
R-squared	0.118	0.127	0.016	0.023	0.021	0.041	0.028	0.062	0.208	0.234
<i>Panel B: Year-by-Year</i>										
PE SME $\times$ 2020	0.003 (0.0219)	0.006 (0.022)	-0.009 (0.006)	-0.011* (0.006)	-0.006 (0.005)	-0.005 (0.005)	-0.003 (0.006)	-0.004 (0.006)	0.056*** (0.021)	0.056*** (0.021)
PE SME $\times$ 2021	0.024 (0.021)	0.027 (0.022)	-0.011* (0.006)	-0.013** (0.006)	-0.004 (0.005)	-0.006 (0.005)	-0.002 (0.006)	-0.003 (0.006)	0.006 (0.021)	0.003 (0.0219)
PE SME $\times$ 2022	-0.016 (0.021)	-0.018 (0.022)	-0.019*** (0.006)	-0.019*** (0.006)	-0.023*** (0.005)	-0.022*** (0.005)	-0.022*** (0.006)	-0.022*** (0.006)	-0.032 (0.021)	-0.035* (0.021)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	5042	4928	5042	4928	5047	4933	4939	4933	5047	4933

Table 3 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within the performance metrics. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients. Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Panel B indicates that the negative impact of PE-ownership on EBITDA and net income occurred in 2022, with a relative 2.2% decrease in EBITDA compared to the control group. 2020 and 2021 show marginally negative coefficients for both variables, although both lack statistical significance. These findings are in line with exhibits A3 and A4 in the appendix, which present graphs of the development of EBITDA and net income divided by total assets, normalized to 2019 values. The exhibits show that both firm samples experience declines across the profitability measures in 2020, followed by a recovery in 2021. A deviation, however, occurs in 2022, where PE-firms face yet another year of declining profitability while the control group continues to recover. PE-backed SMEs underperform in terms of profit margin throughout all three years of the crisis, with statistical significance, although the biggest deviation occurs, here too, in 2022.

No impact from PE-ownership can be seen in columns 1 and 2 in panel B for revenue, confirming the initial findings from panel A and showing consistent trends across the entirety of the crisis for the variable. For assets, the results vary more across each year. As column 12 in panel B shows, PE-backed firms experience a big increase of 5.4% in asset size compared to control firms in 2020 with a confidence level above 95%. In 2021, no changes appear between the treatment and control group, while in 2022, PE-ownership sees a notable 3.5% decline in asset value. The initial, and economically large, increase in assets in 2020 is therefore offset by asset developments during the following years of the crisis. This development explains the statistically insignificant change in assets when considering the crisis period as a whole, from panel A. The trends in exhibit A2 in the appendix support these findings.

5.2 Financial Engineering Metrics

Table 4. DiD Regressions on Financial Engineering

<i>Panel A: Crisis Period</i>								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Debt Contrib. / Assets		Equity Contrib. / Assets		Solvency		Cost of Liabilities	
PE SME $\times$ Crisis	0.017*	0.020**	0.009	0.007	-0.024***	-0.030***	-0.001	-0.001
	(0.009)	(0.009)	(0.005)	(0.005)	(0.006)	(0.006)	(0.001)	(0.001)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	5029	4921	5029	4921	5047	4933	4892	4789
P-Value	0.065	0.030	0.101	0.192	0.000	0.000	0.480	0.468
R-squared	0.007	0.020	0.007	0.020	0.008	0.024	0.004	0.005
<i>Panel B: Year-by-Year</i>								
PE SME $\times$ 2020	0.055***	0.057***	0.013*	0.013*	-0.014*	-0.014*	0.000	0.001
	0.012	0.012	0.007	0.007	0.008	0.008	0.001	0.001
PE SME $\times$ 2021	-0.020	-0.017	-0.003	-0.005	-0.010	-0.014*	-0.001	-0.001
	0.012	0.012	0.007	0.007	0.008	0.008	0.001	0.001
PE SME $\times$ 2022	-0.005	-0.004	0.006	0.005	-0.020**	-0.025***	0.000	0.000
	0.012	0.012	0.007	0.007	0.008	0.008	0.001	0.001
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	5029	4921	5029	4921	5047	4933	4892	4789

Table 4 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within financial engineering. Respective standard errors (ε_{it}) are provided in parentheses below the coefficients. Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Panel A from Table 5 shows that PE-backing increases access to debt financing by 2%, normalized to total assets, throughout the crisis. The interaction coefficient rises marginally as control variables are implemented, coupled with a lower p-value. Debt contribution is statistically significant in both the base model and the model augmented with control variables. Equity contribution also bears a positive coefficient, although with no statistical significance for both the base and augmented model. We therefore conclude that PE-backing holds no benefit to SMEs regarding equity injections when considering the crisis as a whole. Greater differences in debt financing compared to equity injections between the two groups, throughout the crisis, indicate that PE firms make use of leverage during the exogenous shocks. As seen in panel A, solvency decreases by 3% as a result of the crisis interaction term when we account for control variables, with a p-value level below 1%.

Looking into year-by-year regressions, in panel B (Table 4), we see that the overall positive coefficient in debt financing is a levelled out version of yearly discrepancies. Specifically, PE-backing increases debt contribution by 5.7% more in the first year of the pandemic than the control group. This plateaus during the following years with a negative coefficient in 2021 and 2022, although with no statistical significance. The same case is applicable for equity contribution. PE-backed SMEs enjoy slightly greater equity injections from investors in 2020, around 1.4% greater than that of the control group. The coefficient for financing through equity in 2020 is significant at the 10% level. This too appears to decrease in the following years, although, similarly to debt contribution, this decline relative to the control group is statistically insignificant. These trends of increases in equity and debt contribution, in 2020, are supported by exhibits A6 and A7 in the appendix. Both the treatment and control group increase equity injections in 2020, although the increase is greater for the PE sample. These injection rates subside in the following years for both groups. Exhibit A7 shows that PE-backed SME debt financing increases greatly in 2020 while debt contribution in the control group remains unchanged. However, in 2021, non-PE-backed SMEs catch up to this trend, although not to the same growth rate seen in 2020, while PE-backed SMEs' debt financing subsides. The higher debt and equity contributions in 2020 confirm that asset growth in 2020, among PE-backed firms, is sourced from external financing, rather than organic growth. Rather surprisingly, panel B shows that solvency continues to decline relative to the control group up until 2022. However, no significant differences emerge in debt and equity contribution between the two groups after 2020. This implies that the relative decline in solvency, after 2020, is a result of underperformance in terms of profitability among PE-backed SMEs, thereby comparatively decreasing shareholders' equity. In regards to cost of liabilities, we find no evidence of PE-backed firms managing to obtain financing at lower interest expenses in both the primary crisis regression model in panel A and the the year-by-year regression in panel B. Both base and augmented regressions show no statistical significance for cost of liabilities.

Summarizing these findings, in the entirety of the crisis, SMEs with PE-ownership make use of more financial engineering through debt contributions and potentially solvency, although the reduced equity to assets ratio is also a byproduct of reduced profitability. Equity contributions and cost of liabilities present no overall changes throughout the crisis period.

5.3 Operational Engineering Metrics

Table 5: DiD Regressions on Operational Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)
	Investments/Assets		Cost/Sales		WC/Assets	
PE SME $\times$ Crisis	0.005 (0.010)	0.006 (0.010)	0.013*** (0.004)	0.014*** (0.004)	-0.011* (0.007)	-0.015** (0.007)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	4856	4840	4932	4923	5047	4933
P-Value	0.629	0.537	0.000	0.000	0.100	0.033
R-squared	0.004	0.005	0.009	0.021	0.004	0.012

Panel B: Year-by-Year

	(1)	(2)	(3)	(4)	(5)	(6)
	Investments/Assets		Cost/Sales		WC/Assets	
PE SME $\times$ 2020	0.053*** 0.014	0.053*** 0.014	0.004 0.005	0.005 0.005	0.004 0.009	0.003 0.009
PE SME $\times$ 2021	-0.029** 0.014	-0.028** 0.014	0.005 0.005	0.006 0.005	-0.003 0.009	-0.005 0.009
PE SME $\times$ 2022	-0.015 0.014	-0.014 0.014	0.014*** 0.005	0.015*** 0.005	-0.022** 0.009	-0.025*** 0.009
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	4856	4840	4932	4923	5047	4933

Table 5 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within operational engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients. Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

In Column 4 of Table 5, operating expenses as a ratio of sales increase comparatively for PE-backed SMEs by 1.4% with strong statistical significance. As section 5.1 shows, profit margin declines by around 2.4% for PE-backed SMEs, relative to the control group while operating expenses as a ratio of sales increased by around 1.4%. This indicates that more than

half of the negative effect in profitability for PE-backed SMEs, compared to the control group, is attributable to an increase in operating expenses. Additionally, PE-backed SMEs appear to hold marginally leaner working capital throughout the crisis period, at around 1.5% less than control group counterparts. These findings become more significant with the inclusion of control variables, seen in column 6. The reduction in working capital can demonstrate, for example, either an inadvertent effect of lower profitability reducing cash reserves, or vice versa a strategic approach in improving inventory management, collection of receivables and elongated payment terms with suppliers as a means of freeing up liquidities. As such, the findings in regards to working capital become more ambiguous when considering the negative impact of PE-ownership on profitability between 2020 and 2022. Lastly, investments in SMEs see no increase from PE-ownership during the compounded crisis period of the COVID-19 pandemic and the invasion of Ukraine war as a whole. Both coefficients for with and without control variables present statistical insignificance.

When delving into the year-by-year analysis in panel B, discrepancies arise between the coefficients for investments presented in panel A and the yearly changes in 2020, 2021, and 2022. While investments display no overall impact from PE-ownership across the two crises combined, investments rise considerably in 2020 by 5.3% for PE-backed SMEs relative to those non-PE-backed. The coefficient for 2020 is strongly statistically significant. This rise in investment comes in conjunction with the notably higher debt financing levels experienced by treatment firms, as well as their marginally greater equity injection levels. However, 2021 sees a relative reduction in investment levels among the treatment sample at 2.8%, followed by no changes between the two groups in 2022. This reverse effect levels out the coefficient in 2020 which explains why there is no overall difference in investments across the joint crises between 2020 and 2022. Interestingly, exhibit A10 in the appendix shows that control firms heavily invest in 2021. At the same time, priorly significant PE-backed investments from 2020 drop. Year-by-year DiD regressions further show that the reduction in working capital within the treatment group, shown in panel A, occurs in 2022. The same can be seen with operating expenses over sales, which increase comparatively for PE-backed SMEs by 1.5% in 2022, partly explaining the divergence in EBITDA and net income levels during the same year.

The combined results from panel A and panel B, from Table 5, show that PE-backed firms make no more use of operational engineering with respect to investments, while they present worse operational efficiency measured by operating expenses. On the other hand, PE-backed firms reduce their working capital, though this can also stem from their relative reductions in profitability levels. The findings therefore suggest that PE-backed companies did not benefit from increased operational engineering in face of the effect of the whole crisis period.

5.4 Comparison of Micro, Small, and Medium Sized Enterprises

We run additional DiD regressions on separate firm-size categories, with results tables shown in exhibit C1 to C3 in the appendix. Micro firms were notably the worst performing relative to their control group counterparts, experiencing comparative declines in net income and EBITDA at 3.9% and 3.8% respectively, when including control variables. Both findings are strongly statistically significant. Staggeringly, revenues are 16.5% less compared to the control group, post-crisis, in conjunction with operating expenses rising by 5.1% as a ratio of sales. Profit margins therefore see a 7% decline. All noted coefficients here are statistically significant. Interestingly, micro enterprises were the biggest beneficiaries in terms of debt financing in 2020, taking on 14.1% more debt relative to control group counterparts. No differences in equity contribution were observed. Furthermore, EBITDA and net income only decreased for these firms in 2022 as compared to non-PE-backed SMEs, by 5.7% and 5.4% respectively. This is therefore what drives the coefficients for the overall crisis. Compare this to the small-sized and medium-sized enterprises, and the comparison is striking. Small PE-backed firms see no change in revenues and a smaller comparative increase in operating expenses relative to sales at 1.5%. Overall, PE-ownership among small sized enterprises sees a smaller negative coefficient in net income and EBITDA post-crisis at 2.6% and 2.7% respectively. Medium sized SMEs are the least negatively affected firms by PE-ownership, seeing overall reductions of 1.3% and 1.0% in net income and EBITDA respectively, compared to the control group. Both size-categories of firms follow the same trends as micro firms, in that profitability drops in 2022 relative to non-PE-backed firms, thereby also driving these coefficients for the entire crisis period.

5.5 Robustness Tests:

Our findings are robust for both the inclusion and exclusion of control variables, with no notable changes in statistical significance between based and augmented models. We additionally run a robustness test on our matching procedure, decreasing the range of the matched financial criteria to 30%, in line with Bernstein et al. (2019). Results are found in exhibit B1 in the appendix. Performance metrics remain unchanged both in terms of coefficients and statistical significance when considering the crisis period as a whole. Previously statistically significant coefficients for operational and financial engineering, however, turn insignificant. Interestingly, the year-by-year regressions remain largely unchanged in terms of coefficients and statistical significance. As such, the trends we observe from panel B in the results tables remain upheld with validity. We run a second robustness test filtering for firms founded before 2000, seen in exhibit B2 in the appendix. We test the assumption that one-year range matching is not required for the founded year criteria when firms are incorporated before 2000, due to concerns about survivorship biases becoming null. Results show minimal variations to our findings, although the coefficients for working capital, debt contribution, and assets lose statistical significance. Cost of liabilities becomes statistically significant. Year-by-year regressions show similar trends to those found in panel B, again implying validity in our observations.

6. Discussion:

The DiD regression yields mixed results compared to prior research. PE-backed firms underperform in all metrics of profitability. Furthermore, PE-backed SMEs see no overall relative changes in revenues or asset size compared to the control group. We therefore reject our initial hypothesis: *PE-backed SMEs operationally perform better short-term than non-PE-backed SMEs following exogenous shocks*. Interestingly, PE-backed companies obtained more debt financing over the course of the crisis, while the net effect of PE-ownership on equity injections is insignificant, contributing to reduced solvency combined with reduced profitability levels. Year-by-year differences appear for debt and equity financing levels, indicating discrepancies in the effects of the two crises interacting with PE-ownership. Considering the overall effects, we partially accept the second hypothesis: *PE-backed SMEs make use of comparatively more financial engineering than non-PE-backed SMEs following exogenous shocks*. Lastly, we find no evidence of PE-ownership increasing operational engineering over the course of the crisis compared to the crisis group. Changes in working capital among PE-backed firms, as a channel of operational engineering, are challenged by the alternative observation that PE-backed firms are less cost efficient. Year-by-year fluctuations are also present between coefficients of investments, operating expenses as a ratio of sales, and working capital. Yet, the net effects of PE-ownership appear to be overall null in this channel of value creation. We therefore reject the third hypothesis: *PE-backed SMEs make use of comparatively more operational engineering than non-PE-backed SMEs following exogenous shocks*.

The results for our performance metrics contradict general findings from prior research on the value creation implemented by PE-ownership, particularly during times of crisis (Bernstein et al., 2019; Lavery and Wilson, 2022; Boucly et al., 2011; Gompers et al., 2022). Alternative explanations must therefore arise as to why such discrepancies in findings appear. First, we extend our crisis period compared to prior research, thereby combining two unrelated exogenous shocks into one crisis. This adds an additional stress test to PE-ownership, thereby making differing results more reasonable. We see that EBITDA and net income only decline among PE-backed firms, with significance, in 2022, implying that it was the Ukraine war which formed the discrepancies in performance between PE-backed and non-PE-backed SMEs. Secondly, and most notably, these findings are centralized on a very specific and vulnerable size-category of firms. SMEs were the worst hit firms during both the COVID-19 pandemic and the Ukraine war. Any changes in consumer demand, supply chain fluidity, credit markets, policies and other market conditions significantly affect smaller sized firms with already lower short-term liquidity buffers, small market shares, less economies of scale and operational expertise, in conjunction with lower access to capital financing. The analysis therefore is given an additional layer for consideration of the operational and financial implications of the crisis on the sampled firms.

While the results on PE portfolio firm performance contradict prior research, our findings within financial engineering are in line with Bernstein et al. (2019) and Lavery and Wilson (2022) when concerning debt contribution and solvency, although this is not the case for equity contribution. These findings, however, regard the net effect of the crisis. The substantial rise in debt financing, in 2020, among PE-backed SMEs, as well as marginally greater access to equity contribution, offers an additional perspective for analysis. Namely, 2020 is the most notable period of financial engineering among PE-backed firms, and is therefore what drives the coefficients for debt and equity contribution in Table 4 primarily. The results from the year strongly support prior research arguments that PE firms alleviate financial constraints by providing portfolio firms with additional sources of external financing, through debt and equity. This ability to source external financing stems from strong banking relationships, debt renegotiation expertise, reduced information asymmetry from majority ownership, as well as the existence of uninvested “dry-powder” in PE funds (Bernstein et al., 2019). Combine these abilities with an eased credit market, displaying near-zero benchmark interest rates, it comes to no surprise that PE firms offered an extensive pathway to easing liquidity constraints through particularly debt financing (Axelson, Jenkinson, Strömberg, and Weisbach, 2013).

The rise in leverage is argued to provide a value-creating channel for firms to handle short-term liquidity constraints, financing short-term operations, and invest into profitable projects and asset classes at a time of high uncertainty. This thereby contributes to operational performances and profitability. The impact of debt contribution on investments is clearly seen, as both rise by over 5% relative to non-PE-backed firms in 2020. Financial engineering therefore contributed to increased operational engineering through heightened investment levels in 2020. Furthermore, aside from reduced profit margins, PE-backed SMEs did not underperform within any performance metrics in 2020 and 2021, implying the financial engineering allowed firms to upkeep and finance short-term operations and operational efficiency during the COVID-19 pandemic.

The ‘catch-up’ in debt financing among non-PE-backed SMEs during 2021 can be explained by the market recovery that year. First, as the immediate impacts of COVID-19 subsided, and markets stabilized relative to the prior year, creditors revisited previously cautious approaches to lending (European Central Bank, 2022). Consequently, the advantages to debt financing from strong banking relationships and reduced information asymmetries among PE-backed firms subsided. Additionally, by 2021, PE-backed SMEs were already leveraged in relation to the control group, leaving less wiggle room for additional borrowing during this year. While potentially value creating during 2020 and 2021, the leveraging had also left PE-backed SMEs particularly vulnerable to the unpredictable, yet oncoming Ukraine war. PE-backed firms were already 2% more leveraged in 2019, which, in conjunction with two successive years of a relative increase in debt to assets, creates greater implications for their financial stability in 2022, when yet another crisis hits.

Bernstein et al. (2019) show that firms displaying higher leverage ratios pre-crisis face reduced investment levels post-exogenous shock. Furthermore, Lavery and Wilson (2022) find that the positive impact of PE-ownership on sales, EBITDA, and asset growth are reduced among more levered firms going into the COVID-19 pandemic. Both studies source these findings to the fact that higher pre-existing debt levels hamper firms' abilities to acquire further debt and equity injections, thereby reducing performances during crises. Bernstein et al. (2019) and Lavery and Wilson (2022) suggest that performance during a crisis is mostly up-kept by the ability to continuously use financial engineering, while PE firms' ability to improve profitability metrics through operational engineering remains relatively limited. Our results lean towards this argument, although we further present findings on underperformance. Despite the invasion of Ukraine, and its related economic implications, non-PE-backed SMEs continued to recover in profitability from 2021 onwards, after an initial dip in 2020. Recovery is also observed among PE-backed SMEs during 2021. However, a divergence in 2022 is clear, as their respective profitability trends turn negative once more. In fact, it is 2022 which appears to drive the overall negative coefficients for profitability among the PE-backed sample for the overall crisis. We note earlier that no underperformance was seen, apart from profit margins, throughout the COVID-19 crisis, however, PE-backed SMEs did perform worse when the Ukraine war began.

In line with Bernstein et al. (2019) and Lavery and Wilson (2020), we reason the underperformance firstly due to the fact that prior high leverage had limited PE-backed SMEs' ability to finance their operations relative to their non-PE-backed counterparts going into the Ukraine war. Furthermore, these firms must allocate greater proportions of cash flows to service debt, leaving them less cash to finance operational activities and the upkeep of operational efficiency. The link between low solvency in 2021 and underperformance in profitability in 2022 is further displayed by the comparisons between micro enterprises and small and medium-sized firms. Micro-sized firms were the biggest beneficiaries for debt contribution from PE-ownership in 2020, but were also those who experienced the biggest hampering in profitability, sales, and operating expenses compared to the control group in 2022.

The overall lack of operational engineering and, in particular, its underuse in 2022 within cost efficiency can also be a culprit to the underperformance among PE-ownership. According to Gompers et al. (2022), during times of crisis, PE-firms reduce working hours spent on finding new potential acquisitions and instead focus on aiding portfolio companies. The focal areas of improvement regard reducing mostly operational expenses as well as maintaining or increasing sales. However, despite this argument, operating expenses divided by sales increased in 2022 among PE-backed SMEs year with statistical significance, relative to non-PE-backed firms. Working capital does decline among PE-backed firms, which is a method of freeing up cash flow by reducing, for example, inventory holdings and accounts receivables, and using this for investments and repaying debt. However, the results indicate that the lack of cost efficiency within PE-backed SMEs outweigh any benefits from a leaner working capital, as seen by the

profitability metrics. Humphrey-Jenner (2005) finds that the capabilities of effective operational engineering by PE firms is hampered when portfolio companies are of smaller sizes. This presents an argument as to why our findings, focused on SMEs, differ to those of Bernstein et al. (2019) and Lavery and Wilson (2022), where the average PE-backed firm is a mid-cap corporation. As PE funds hold more, but smaller firms, this leaves PE employees stretched extra thin in aiding portfolio firms during times of crisis. Average manpower and hours spent per firm decline while adapting to the needs of each small enterprise craves more diversified manpower. This poses the risk of mismanagement and misguidance, and therefore, causes the implementation of expertise held by PE-ownership to become additionally challenging.

Our study, overall, finds that PE-backed SMEs did not manage the period between 2020 to 2022 equally well to firms with alternative ownership structures. The inclusion of multi-phase crises diminished PE firms' ability to match operational and financial engineering strategies, presenting a broader limitation of PE-ownership during periods of prolonged crisis. In line with common criticisms, PE firms took more risk towards portfolio SMEs through outlevering non-PE-backed firms combined with an inability to effectively manage operational engineering channels. These findings therefore shed light on the risks of financial engineering, as a channel of value creation, inadvertently becoming a channel of value-destruction for already vulnerable SMEs. As such, increased consciousness on risk aversion is required to be able to adapt to prolonged periods of crisis arising from exogenous shocks.

7. Limitations:

Similar to Bernstein et al. (2019), our results present low R-squared values for each dependent variable. This implies that the chosen DiD regression control variables and interaction term do not explain a larger extent of the dependent variables' standard error. Thus, there are other variables not accounted for in the model. However, due to the nature of the two crises relating largely to the social sciences, it becomes natural that many macroeconomic, political, sociological variables are not accounted for. Additionally, the focus of the DiD regression remains on the interaction term. A low p-value for the interaction term coefficient therefore implies there is no cause for concern, as the results display significance on the effect of the variable. Another limitation regards the measurability of operational engineering. While we incorporate metrics for this channel of value creation, it is difficult to take into account the tangible impact of consultation services from PE-firms to portfolio companies or changes in operative strategies. Working capital and operating expenses are mere representations of the results of operational engineering, and are thus more dependent upon interpretation. Additionally, the over-representation of certain countries in our sample introduces geographical biases. This is particularly true considering certain nations are specialized towards specific industries, such as Germany towards the manufacturing industry, and France towards retail trade. As the differences in performances between the treatment and control group may vary depending on industry and wider macro-economic environment, this implies that our findings may be

overweighted toward certain nations and less applicable to others. We argue, however, that our findings maintain applicability, not only to underrepresented nations in our sample, but also externally. We also recognize that the Ukraine war and its effects extend beyond 2022. Financial reports after this year were not used, however, simply due to the limited availability where the sample remaining may skew coefficient findings.

8. Conclusion

8.1. Summary

This paper studies whether PE-backed SMEs outperformed non-PE-backed SMEs upon the onset of the COVID-19 pandemic and the Ukraine war. We extend this by delving into whether PE-backing benefits SMEs during this period through two potential channels of value creation: financial and operational engineering. Contrary to previous research, matched DiD regressions conducted show that PE-backed SMEs do not outperform in terms of profitability during multi-phase crises. In fact, underperformance is observed after the Ukraine war began. While previous research focuses on single occurring crises, the inclusion of two back-to-back exogenous shocks forms a true stress test on PE-ownership. We find that profitability vulnerabilities in PE-backed SMEs were attributed to initial external financing in 2020 through debt, in combination to no increased benefits from operational engineering throughout both crises. As such, we conclude that PE-ownership does not drive value creation among SMEs when forced to adapt to prolonged periods of economic downturn. These insights stress the need for nuanced assessments on PE's role in wider economic stability to upcoming financial crises or exogenous shocks.

8.2 Further Development of Research

In line with our argument that operational engineering becomes more challenging for PE firms when targeted towards smaller portfolio firms, an interesting extension to the paper would be to reverse the analysis and focus the effects of the owner size on operational engineering. Further inclusion of additional variables for operational engineering is also a useful extension, although measuring PE owners' expertise and the objective benefits from information sharing towards portfolio firms remains challenging. Before-and-after survey methodologies for crises provide a good beginning in quantifying operational engineering (Gompers et al., 2016; Gompers et al., 2022), in addition to including more variables to those we used in this study. Additionally, considering the lag effect of exogenous shocks, a time-extended analysis to incorporate post-crisis performance beyond 2022 would provide valuable insights into the long-run implications of PE ownership on SME performance after our crisis period.

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Appendix A: Variable Graphs

Exhibit A1: Log of Operating Revenue

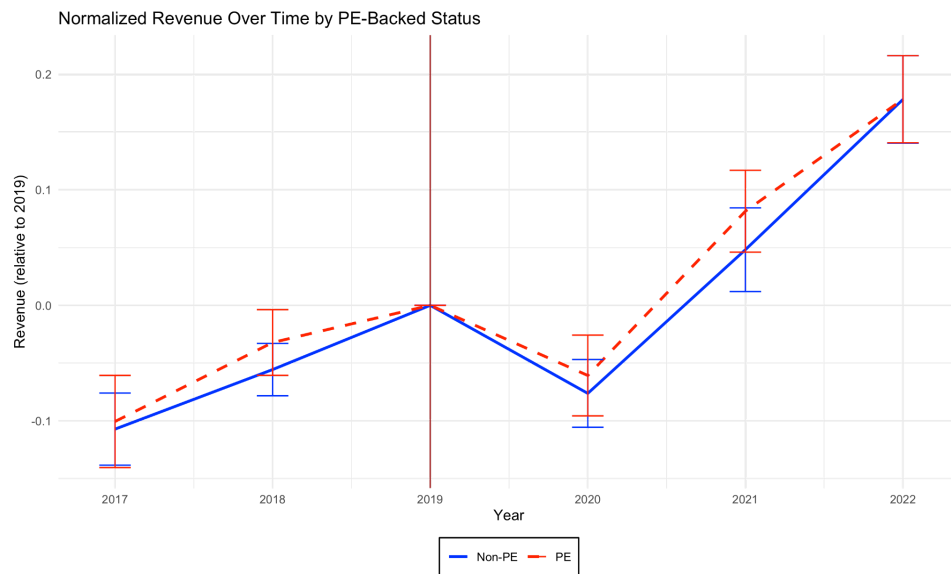


Exhibit A1 illustrates the change in mean operating revenue, in its logarithmic value, between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A2: Log of Total Assets

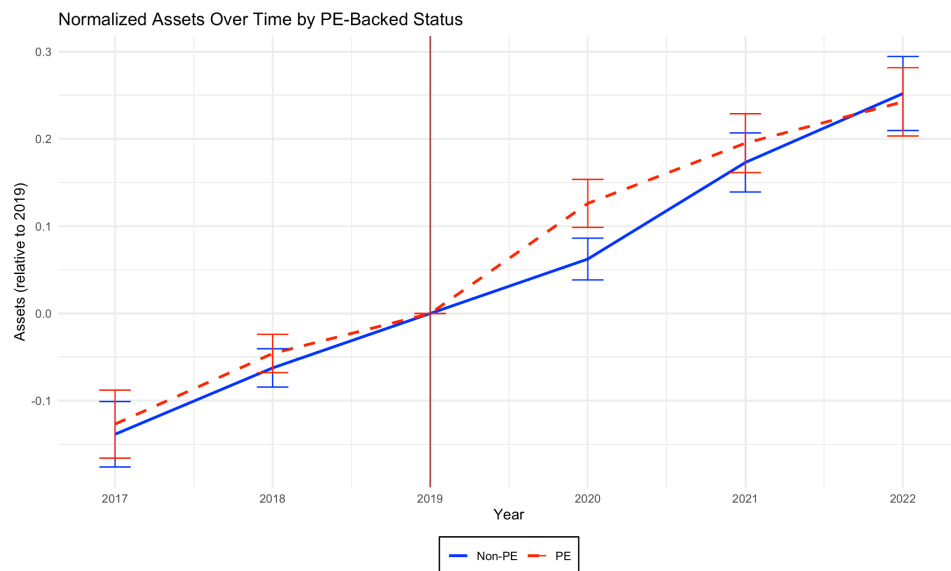


Exhibit A2 illustrates the change in mean assets, in its logarithmic value, between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A3: EBITDA/Assets

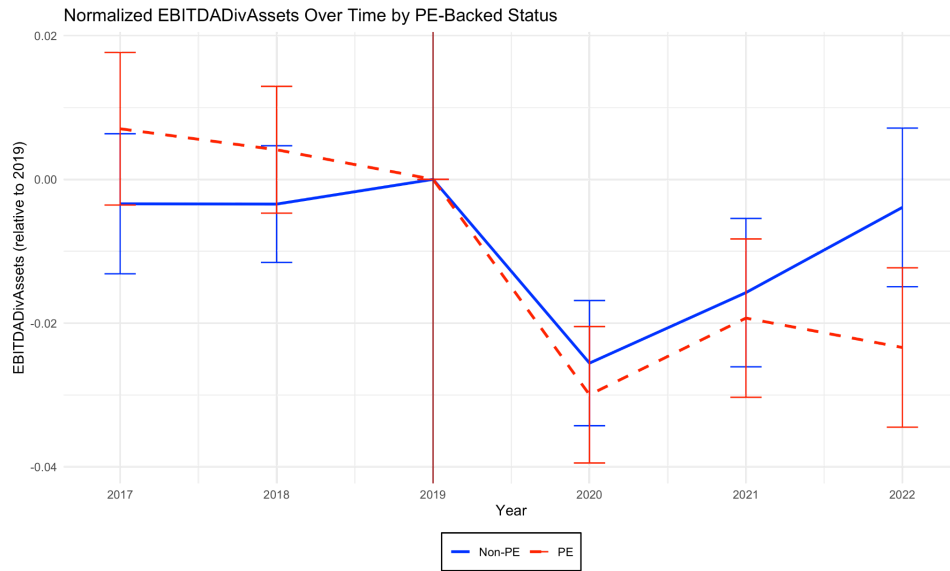


Exhibit A3 illustrates the change in mean EBITDA by assets between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A4: Net Income/Assets

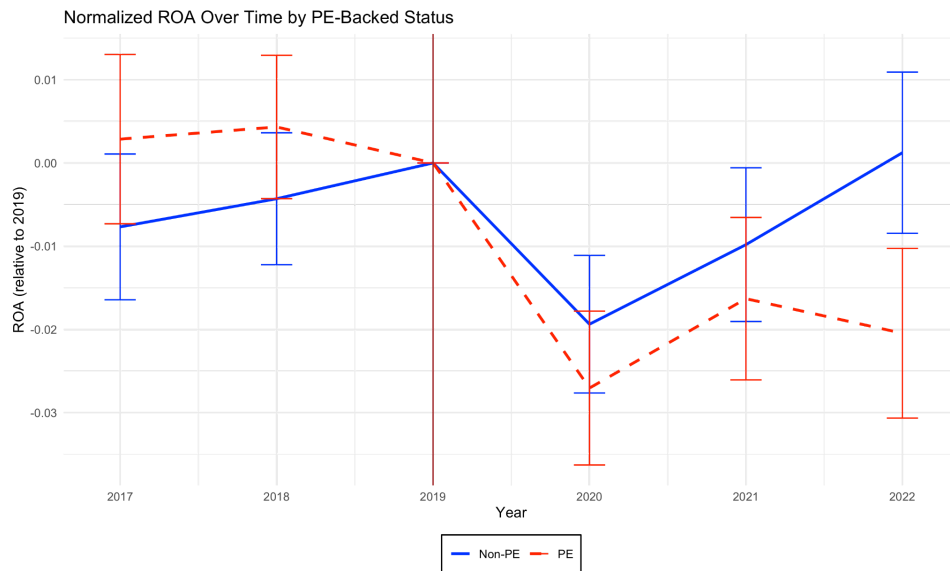


Exhibit A4 illustrates the change in mean net income by assets, in its logarithmic value, between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A5: Profit Margin

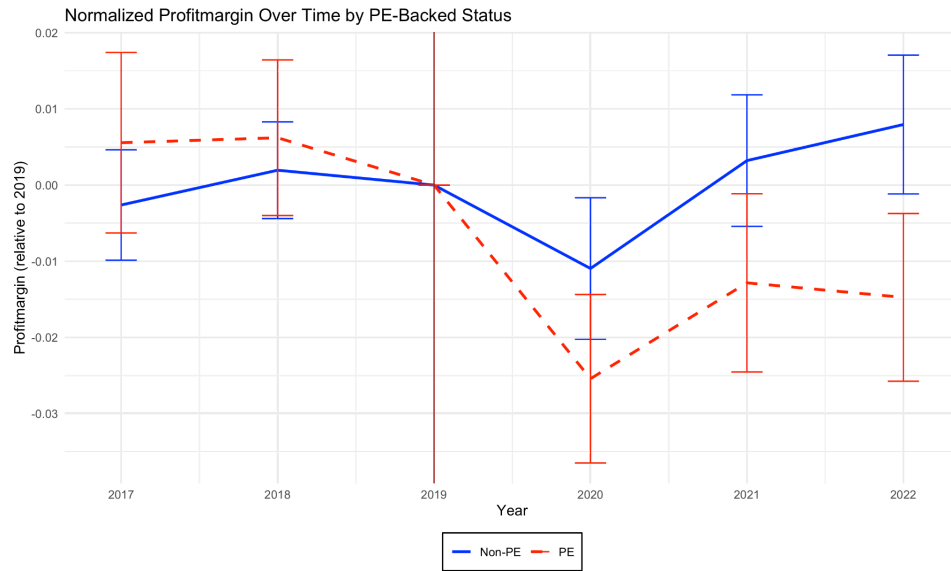


Exhibit A5 illustrates the change in mean profit margin between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A6: Equity Contribution/Assets

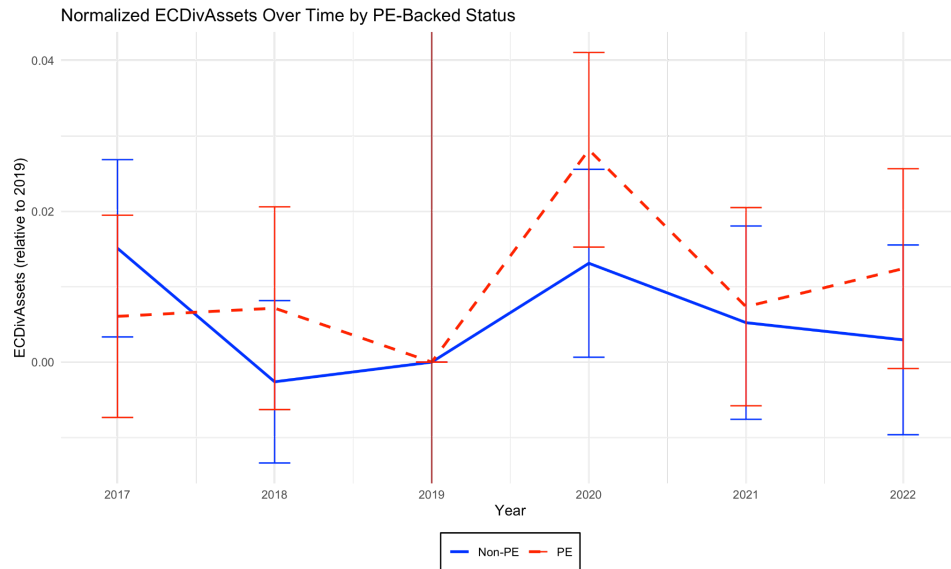


Exhibit A6 illustrates the change in mean equity contribution divided by assets between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A7: Debt Contribution/Assets

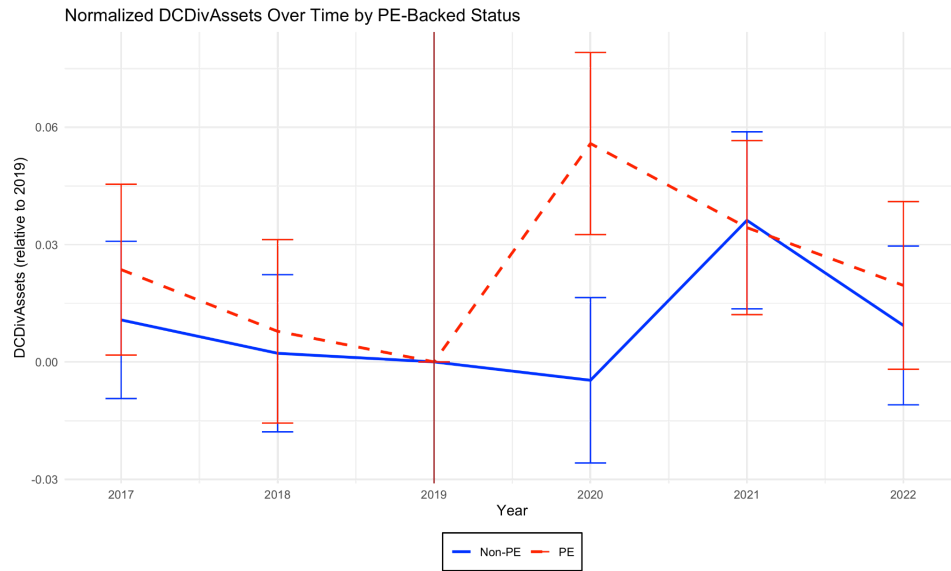


Exhibit A7 illustrates the change in mean debt contribution divided by assets between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A8: Solvency

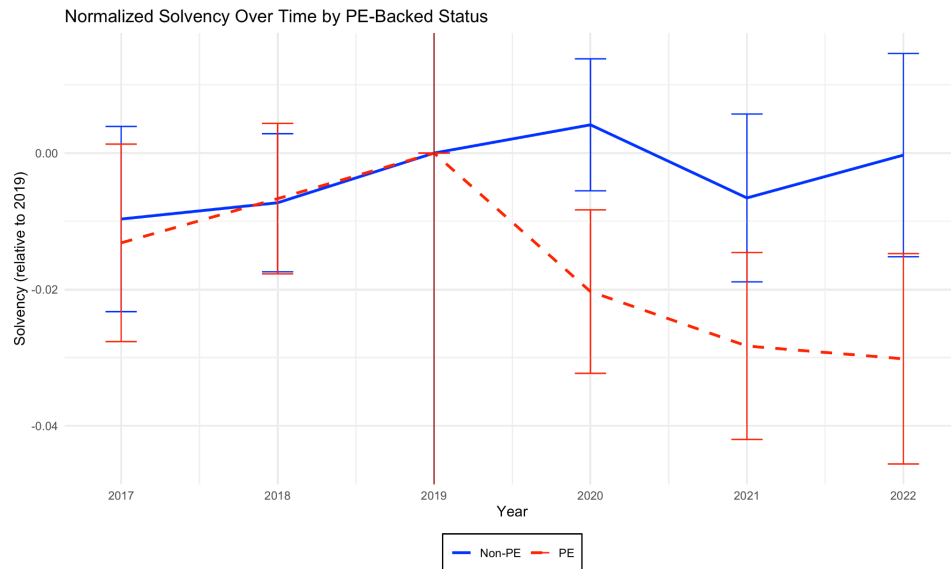


Exhibit A8 illustrates the change in the mean solvency ratio between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A9: Cost of Liabilities

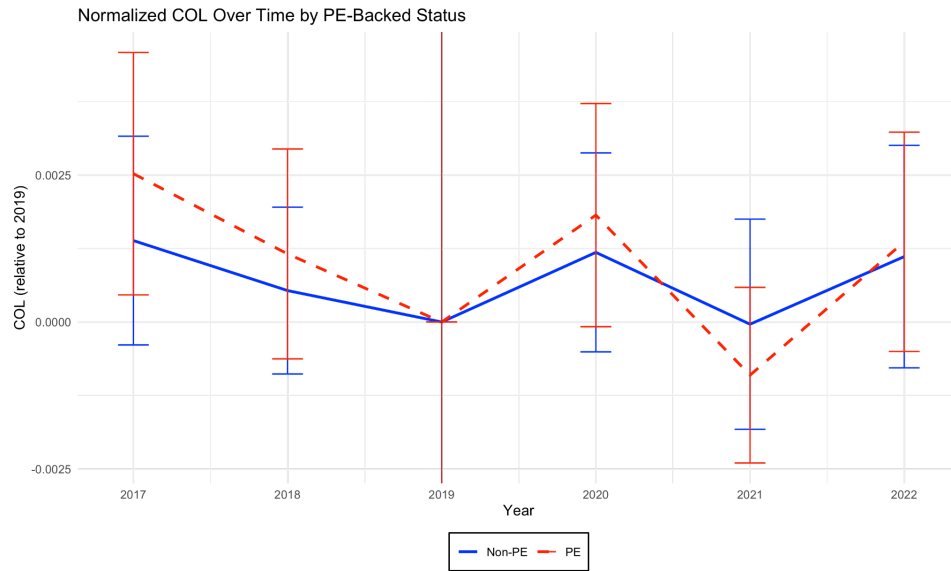


Exhibit A9 illustrates the change in mean cost of liabilities between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A10: Investments/Assets

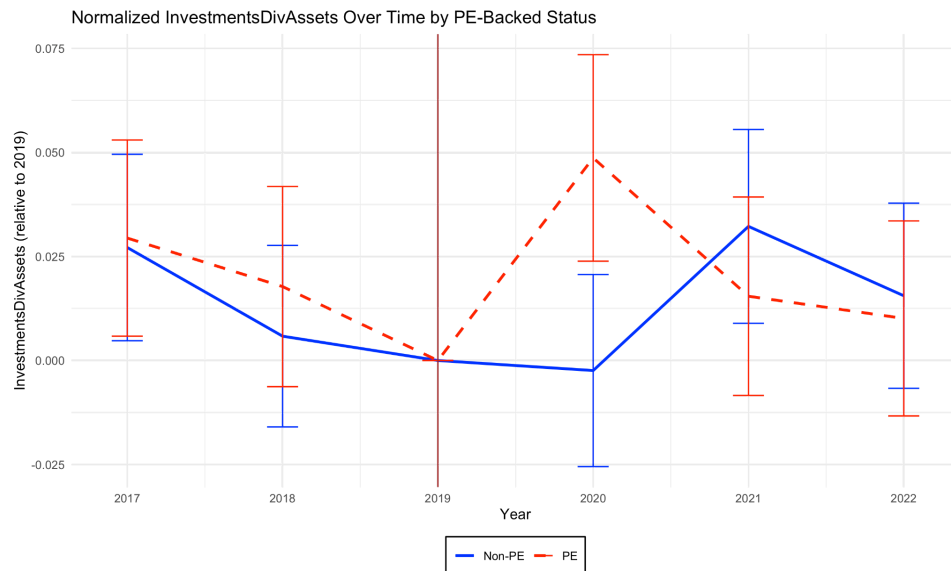


Exhibit A10 illustrates the change in mean investments divided by assets between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A11: Operating Expenses/Sales

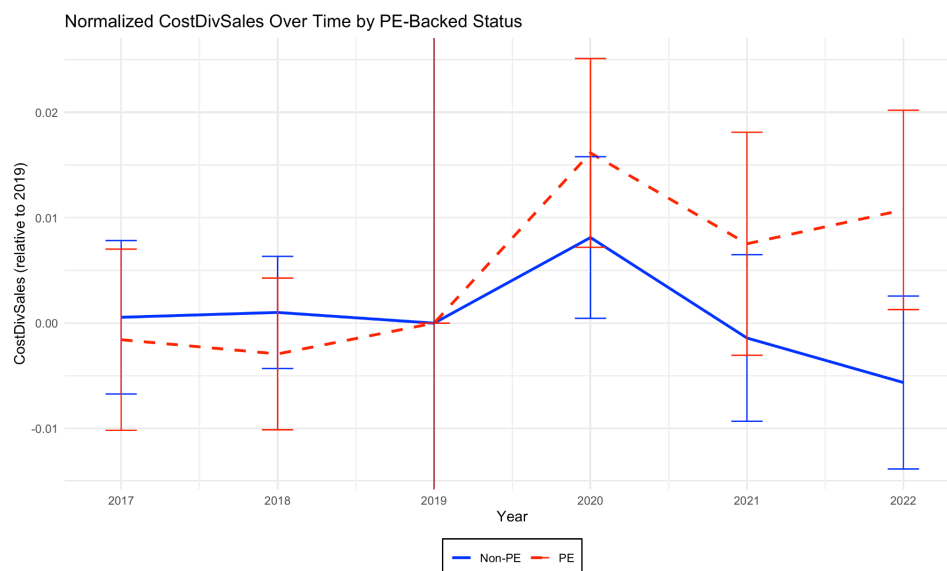


Exhibit A11 illustrates the change in mean operating expenses divided by sales between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Exhibit A12: Working Capital/Assets

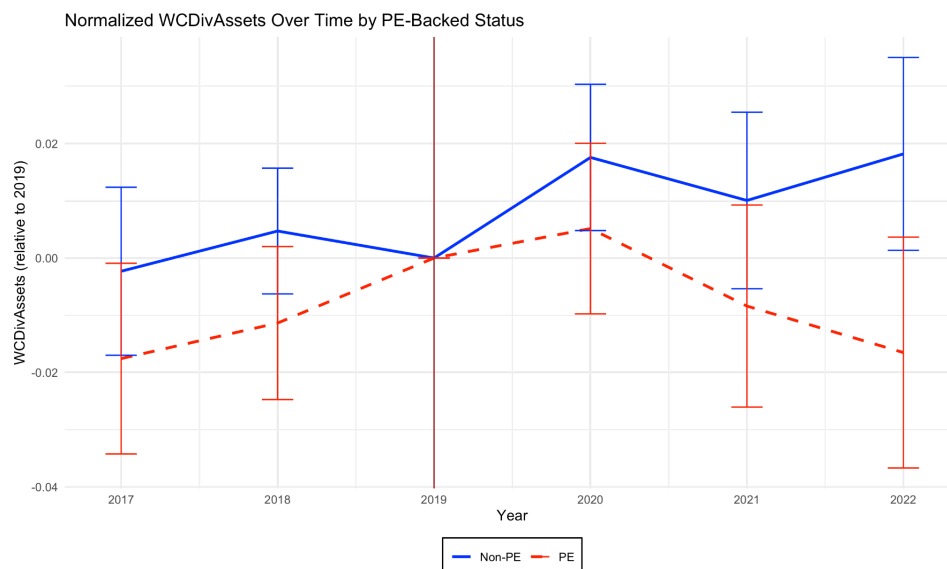


Exhibit A12 illustrates the change in mean working capital divided by assets between 2017 to 2022 for both PE-backed and non-PE-backed SMEs in the matched sample. Values are normalized to the base period, 2019, before the crisis period begins in 2020. This is to capture an illustrative effect of the crisis on both the PE-backed and non-PE-backed sample. Values are winsorized to the 2% level to remove any influences from extreme outliers.

Appendix B: Robustness Tests

Exhibit B1: Robustness Test on Matching within 30% Range

Table B1.1: DiD Regressions on Performance Metrics

<i>Panel A: Crisis Period</i>										
	(1)	(2)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Revenue (log)		Profit Margin		Net Income/Assets		EBITDA/Assets		Assets (log)	
PE SME $\times$ Crisis	-0.023	-0.023	-0.015***	-0.016***	-0.011**	-0.011**	-0.008	-0.009*	0.014	0.009
	0.020	0.020	0.004	0.004	0.005	0.005	0.006	0.005	0.020	0.019
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2875	2821	2875	2821	2875	2821	2823	2821	2875	2821
P-Value	0.253	0.263	0.000	0.000	0.018	0.018	0.126	0.093	0.476	0.656
R-squared	0.137	0.154	0.010	0.025	0.020	0.047	0.027	0.070	0.262	0.299
<i>Panel B: Year-by-Year</i>										
PE SME $\times$ 2020	0.013	0.014	-0.005	-0.004	-0.002	0.000	0.000	0.000	0.081***	0.077***
	0.027	0.027	0.006	0.006	0.006	0.006	0.007	0.007	0.027	0.026
PE SME $\times$ 2021	0.004	0.008	-0.014**	-0.015***	-0.002	-0.004	0.000	0.000	-0.006	-0.008
	0.027	0.027	0.006	0.006	0.006	0.006	0.007	0.007	0.027	0.026
PE SME $\times$ 2022	-0.059**	-0.063**	-0.008	-0.010	-0.016**	-0.017***	-0.016**	-0.016**	-0.049**	-0.054**
	0.027	0.027	0.006	0.006	0.006	0.006	0.007	0.007	0.027	0.026
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2875	2821	2875	2821	2875	2821	2875	2821	2875	2821

Table B1.1 reports the coefficients (β_i) from a difference-in-differences model for all dependent variables within the performance metrics. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table B1.2: DiD Regressions on Financial Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Debt Contrib. / Assets		Equity Contrib. / Assets		Solvency		Cost of Liabilities	
PE SME $\times$ Crisis	0.008	0.011	0.001	0.001	-0.017**	-0.023***	0.001	0.001
	0.011	0.011	0.006	0.006	0.007	0.007	0.001	0.001
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2868	2820	2868	2820	2875	2821	2791	2742
P-Value	0.496	0.346	0.844	0.895	0.018	0.001	0.318	0.376
R-squared	0.012	0.019	0.010	0.025	0.014	0.038	0.007	0.008

Panel B: Year-by-Year

PE SME $\times$ 2020	0.062***	0.064***	0.007	0.007	-0.014	-0.016*	0.001	0.001
	0.015	0.015	0.008	0.008	0.009	0.009	0.001	0.001
PE SME $\times$ 2021	-0.044***	-0.040***	-0.001	-0.002	-0.004	-0.009	-0.001	-0.001
	0.015	0.015	0.008	0.008	0.009	0.009	0.001	0.001
PE SME $\times$ 2022	-0.004	-0.005	-0.003	-0.004	-0.012	-0.018*	0.001	0.001
	0.015	0.015	0.008	0.008	0.009	0.009	0.001	0.001
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2868	2820	2868	2820	2875	2821	2791	2742

Table B1.2 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within financial engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table B1.3: DiD Regressions on Operational Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)
	Investments/Assets		Cost/Sales		WC/Assets	
PE SME $\times$ Crisis	-0.002 0.012	-0.001 0.012	0.004 0.004	0.005 0.004	-0.005 0.009	-0.011 0.009
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	2799	2792	2823	2816	2875	2821
P-Value	0.871	0.941	0.335	0.246	0.579	0.200
R-squared	0.007	0.008	0.005	0.027	0.006	0.021

Panel B: Year-by-Year

PE SME $\times$ 2020	0.066*** 0.016	0.066*** 0.016	-0.003 0.006	-0.003 0.005	-0.004 0.012	-0.005 0.012
PE SME $\times$ 2021	-0.047*** 0.017	-0.046*** 0.017	0.003 0.006	0.004 0.005	0.004 0.012	-0.001 0.012
PE SME $\times$ 2022	-0.022 0.017	-0.021 0.017	0.007 0.006	0.007 0.005	-0.009 0.012	-0.014 0.012
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	2799	2792	2823	2816	2875	2821

Table B1.3 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within operational engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients. Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Exhibit B2: Robustness Test on Firms Founded Before 2000

Table B2.1: DiD Regressions on Performance Metrics

<i>Panel A: Crisis Period</i>										
	(1)	(2)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Revenue (log)		Profit Margin		Net Income/Assets		EBITDA/Assets		Total Assets (log)	
PE SME $\times$ Crisis	0.017	0.017	-0.013***	-0.014***	-0.009**	-0.009**	-0.006	-0.006	0.020	0.015
	0.016	0.016	0.004	0.004	0.004	0.004	0.005	0.005	0.016	0.015
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3516	3444	3516	3444	3516	3444	3448	3444	3516	3444
P-Value	0.279	0.300	0.004	0.001	0.045	0.041	0.225	0.196	0.194	0.317
R-squared	0.125	0.133	0.013	0.022	0.017	0.041	0.023	0.062	0.221	0.262
<i>Panel B: Year-by-Year</i>										
PE SME $\times$ 2020	0.007	0.008	-0.005	-0.007	-0.002	-0.001	0.000	0.000	0.061***	0.059***
	(0.022)	(0.022)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.021)	(0.020)
PE SME $\times$ 2021	0.030	0.031	-0.007	-0.008	-0.003	-0.004	0.001	0.000	0.018	0.013
	(0.022)	(0.022)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.0219)	(0.020)
PE SME $\times$ 2022	-0.006	-0.009	-0.011*	-0.011*	-0.011*	-0.011**	-0.011*	-0.011*	-0.042**	-0.045**
	(0.022)	(0.022)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.021)	(0.020)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3516	3444	3516	3444	3516	3444	3448	3444	3516	3444

Table B2.1 reports the coefficients (β_i) from a difference-in-differences model for all dependent variables within the performance metrics. Respective standard errors (ϵ_i) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table B2.2: DiD Regressions on Financial Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Debt Contrib. / Assets		Equity Contrib. / Assets		Solvency		Cost of Liabilities	
PE SME $\times$ Crisis	0.004	0.008	0.004	0.003	-0.018***	-0.024***	0.001	0.001
	0.010	0.010	0.006	0.006	0.006	0.006	0.001	0.001
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3505	3439	3505	3439	3516	3444	3442	3381
P-Value	0.674	0.461	0.486	0.608	0.004	0.000	0.199	0.139
R-squared	0.008	0.016	0.014	0.031	0.007	0.025	0.008	0.008

Panel B: Year-by-Year

PE SME $\times$ 2020	0.061***	0.061***	0.005	0.004	-0.021**	-0.022***	0.002*	0.002**
	(0.014)	0.014	(0.007)	(0.007)	(0.009)	(0.008)	(0.001)	(0.001)
PE SME $\times$ 2021	-0.032**	-0.030**	0.004	0.003	-0.007	-0.011	-0.001	-0.001
	(0.014)	0.014	(0.007)	(0.007)	(0.009)	(0.008)	(0.001)	(0.001)
PE SME $\times$ 2022	-0.021	-0.018	-0.002	-0.002	-0.006	-0.010	0.001	0.001
	(0.014)	0.014	(0.007)	(0.007)	(0.009)	(0.008)	(0.001)	(0.001)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3505	3439	3505	3439	3516	3444	3442	3381

Table B2.2 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within financial engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table B2.3: DiD Regressions on Operational Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)
	Investments/Assets		Cost/Sales		WC/Assets	
PE SME $\times$ Crisis	0.003 0.011	0.004 0.011	0.006 0.004	0.007* 0.004	-0.004 0.007	-0.008 0.007
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	3417	3403	3446	3439	3516	3444
P-Value	0.784	0.734	0.103	0.070	0.610	0.272
R-squared	0.005	0.006	0.006	0.022	0.003	0.013

Panel B: Year-by-Year

PE SME $\times$ 2020	0.055*** 0.015	0.055*** 0.015	0.001 0.005	0.001 0.005	-0.001 0.010	-0.002 0.010
PE SME $\times$ 2021	-0.031** 0.015	-0.030** 0.015	0.002 0.005	0.002 0.005	0.004 0.010	0.001 0.010
PE SME $\times$ 2022	-0.019 0.015	-0.018 0.015	0.008 0.005	0.008* 0.005	-0.010 0.010	-0.013 0.010
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	3417	3403	3446	3439	3516	3444

Table B2.3 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within operational engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Appendix C: DiD Regressions on Micro, Small, and Medium Sized Firms

Exhibit C1: DiD Regressions on Micro Sized Firms

Table C1.1: DiD Regressions on Performance Metrics

<i>Panel A: Crisis Period</i>										
	(1)	(2)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Revenue (log)		Profit Margin		Net Income/Assets		EBITDA/Assets		Assets (log)	
PE SME $\times$ Crisis	-0.188*** (0.066)	-0.165** (0.066)	-0.075*** (0.026)	-0.07*** (0.027)	-0.042** (0.016)	-0.039** (0.017)	-0.023 (0.017)	-0.038** (0.017)	-0.053 (0.078)	-0.064 (0.082)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	504.00	480.00	504.00	480.00	504.00	480.00	482.00	480.00	504.00	480.00
P-Value	0.005	0.013	0.004	0.009	0.011	0.019	0.184	0.03	0.496	0.439
R-squared	0.115	0.172	0.028	0.035	0.041	0.053	0.024	0.087	0.259	0.275
<i>Panel B: Year-by-Year</i>										
PE SME $\times$ 2020	0.031 0.089	0.049 0.088	-0.050 0.035	-0.045 0.035	-0.020 0.022	-0.019 0.022	-0.005 0.023	-0.013 0.023	0.132 0.105	0.135 0.109
PE SME $\times$ 2021	-0.130 0.089	-0.085 0.088	-0.002 0.035	-0.001 0.035	0.002 0.022	0.004 0.022	0.012 0.023	0.004 0.023	-0.105 0.105	-0.104 0.109
PE SME $\times$ 2022	-0.240*** 0.089	-0.253*** 0.087	-0.082** 0.035	-0.078** 0.035	-0.056*** 0.022	-0.054** 0.022	-0.048** 0.023	-0.057** 0.023	-0.123 0.105	-0.143 0.109
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	504	480	504	480	504	480	482	480	504	480

Table C1.1 reports the coefficients (β_i) from a difference-in-differences model for all dependent variables within the performance metrics. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table C1.2: DiD Regressions on Financial Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Debt Contrib. / Assets		Equity Contrib. / Assets		Solvency		Cost of Liabilities	
PE SME $\times$ Crisis	0.049	0.062	0.008	0.013	-0.016	-0.021	-0.003	-0.003
	0.039	0.04	0.016	0.016	0.024	0.025	0.003	0.003
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	504	480	504	480	504	480	458	434
P-Value	0.208	0.123	0.635	0.423	0.51	0.385	0.382	0.318
R-squared	0.026	0.04	0.009	0.052	0.007	0.017	0.019	0.029

Panel B: Year-by-Year

PE SME $\times$ 2020	0.128**	0.141***	-0.007	0.005	-0.049	-0.053	-0.006	-0.005
	0.052	0.053	0.021	0.022	0.032	0.032	0.004	0.004
PE SME $\times$ 2021	-0.073	-0.057	0.006	0.003	0.012	0.006	-0.005	-0.005
	0.053	0.053	0.021	0.022	0.032	0.032	0.004	0.004
PE SME $\times$ 2022	0.034	0.025	0.015	0.015	0.009	0.009	0.006	0.004
	0.053	0.053	0.021	0.022	0.032	0.032	0.004	0.004
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	504	480	504	480	504	480	458	434

Table C1.2 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within financial engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table C1.3: DiD Regressions on Operational Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)
	Investments/Assets		Cost/Sales		WC/Assets	
PE SME $\times$ Crisis	-0.021 (0.043)	0.004 (0.043)	0.046** (0.023)	0.051** (0.023)	-0.048 (0.031)	-0.049 (0.032)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	448	446	482	480	504	480
P-Value	0.62	0.934	0.043	0.027	0.127	0.132
R-squared	0.012	0.041	0.03	0.06	0.011	0.016

Panel B: Year-by-Year

PE SME $\times$ 2020	0.082 0.057	0.098* 0.056	0.036 0.031	0.038 0.030	-0.034 0.042	-0.042 0.043
PE SME $\times$ 2021	-0.105* 0.057	-0.091 0.056	0.012 0.031	0.014 0.030	-0.027 0.042	-0.034 0.043
PE SME $\times$ 2022	-0.015 0.057	0.000 0.057	0.035 0.031	0.037 0.030	-0.025 0.042	-0.010 0.043
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	448	446	482	480	504	480

Table C1.3 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within operational engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Exhibit C2: DiD Regressions on Small Sized SMEs

Table C2.1: DiD Regressions on Performance Metrics

<i>Panel A: Crisis Period</i>										
	(1)	(2)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Revenue (log)		Profit Margin		Net Income/Assets		EBITDA/Assets		Assets (log)	
PE SME $\times$ Crisis	-0.006 (0.027)	-0.007 (0.028)	-0.017** (0.007)	-0.02*** (0.007)	-0.026*** (0.008)	-0.026*** (0.008)	-0.026*** (0.009)	-0.027*** (0.009)	-0.008 (0.028)	-0.016 (0.029)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1531	1483	1531	1483	1531	1483	1485	1483	1531	1483
P-Value	0.835	0.809	0.012	0.003	0.001	0.001	0.004	0.002	0.782	0.575
R-squared	0.153	0.160	0.012	0.024	0.022	0.055	0.036	0.080	0.258	0.273
<i>Panel B: Year-by-Year</i>										
PE SME $\times$ 2020	-0.012 0.036	-0.007 0.037	0.002 0.009	-0.001 0.009	-0.001 0.011	0.001 0.011	0.000 0.012	0.000 0.012	0.031 0.038	0.029 0.038
PE SME $\times$ 2021	0.028 0.036	0.027 0.037	-0.023** 0.009	-0.025*** 0.009	-0.020* 0.011	-0.024** 0.010	-0.024** 0.012	-0.025** 0.012	-0.011 0.038	-0.015 0.038
PE SME $\times$ 2022	-0.026 0.036	-0.032 0.037	-0.010 0.009	-0.009 0.009	-0.025** 0.011	-0.024** 0.010	-0.023* 0.012	-0.024** 0.012	-0.034 0.038	-0.043 0.038
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1531	1531	1531	1531	1531	1531	1485	1485	1531	1531

Table C2.1 reports the coefficients (β_i) from a difference-in-differences model for all dependent variables within the performance metrics. Respective standard errors (ϵ_i) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table C2.2: DiD Regressions on Financial Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Debt Contrib. / Assets		Equity Contrib. / Assets		Solvency		Cost of Liabilities	
PE SME $\times$ Crisis	0.007 (0.017)	0.008 (0.017)	0.023** (0.010)	0.020** (0.010)	-0.024** (0.011)	-0.030*** (0.011)	0.000 (0.001)	0.000 (0.001)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1524	1482	1524	1482	1531	1483	1478	1435
P-Value	0.66	0.62	0.022	0.047	0.026	0.004	0.799	0.894
R-squared	0.005	0.025	0.018	0.029	0.014	0.037	0.008	0.01

Panel B: Year-by-Year

PE SME $\times$ 2020	0.027 0.022	0.025 0.023	0.014 0.014	0.012 0.014	-0.001 0.014	-0.003 0.014	0.005** 0.002	0.005*** 0.002
PE SME $\times$ 2021	-0.027 0.022	-0.025 0.023	0.006 0.014	0.005 0.014	-0.010 0.014	-0.015 0.014	-0.002 0.002	-0.002 0.002
PE SME $\times$ 2022	0.013 0.023	0.015 0.023	0.022 0.014	0.019 0.014	-0.031** 0.014	-0.037*** 0.014	-0.003 0.002	-0.003 0.002
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1524	1524	1524	1524	1531	1531	1478	1478

Table C2.2 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within financial engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table C2.3: DiD Regressions on Operational Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)
	Investments/Assets		Cost/Sales		WC/Assets	
PE SME $\times$ Crisis	0.006 (0.019)	0.008 (0.019)	0.014** (0.006)	0.015** (0.006)	-0.016 (0.013)	-0.021 (0.013)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	1472	1465	1490	1483	1531	1483
P-Value	0.776	0.691	0.018	0.012	0.228	0.12
R-squared	0.005	0.008	0.01	0.03	0.011	0.029

Panel B: Year-by-Year

PE SME $\times$ 2020	0.025 0.026	0.024 0.026	-0.003 0.008	-0.003 0.008	-0.006 0.018	-0.007 0.018
PE SME $\times$ 2021	-0.036 0.026	-0.035 0.026	0.022*** 0.008	0.023*** 0.008	0.002 0.018	-0.001 0.018
PE SME $\times$ 2022	0.022 0.026	0.024 0.026	0.006 0.008	0.007 0.008	-0.025 0.018	-0.030* 0.018
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	1472	1472	1490	1490	1531	1531

Table C2.3 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within operational engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Exhibit C3: DiD Regressions on Medium Sized SMEs

Table C3.1: DiD Regressions on Performance Metrics

<i>Panel A: Crisis Period</i>										
	(1)	(2)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Revenue (log)		Profit Margin		Net Income/Assets		EBITDA/Assets		Assets (log)	
PE SME $\times$ Crisis	0.029 (0.019)	0.03 (0.019)	-0.021*** (0.005)	-0.022*** (0.005)	-0.013*** (0.005)	-0.013*** (0.005)	-0.010** (0.005)	-0.010** (0.005)	0.050*** (0.018)	0.050*** (0.018)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3007	2965	3007	2965	3012	2970	2972	2970	3012	2970
P-Value	0.129	0.117	0.000	0.000	0.006	0.005	0.047	0.039	0.006	0.005
R-squared	0.130	0.139	0.024	0.031	0.023	0.042	0.027	0.056	0.189	0.228
<i>Panel B: Year-by-Year</i>										
PE SME $\times$ 2020	-0.004 0.026	-0.004 0.026	-0.013* 0.007	-0.014* 0.007	-0.007 0.006	-0.007 0.006	-0.004 0.007	-0.004 0.007	0.062** 0.024	0.062*** 0.024
PE SME $\times$ 2021	0.032 0.026	0.033 0.026	-0.007 0.007	-0.008 0.007	0.001 0.006	0.001 0.006	0.005 0.007	0.005 0.007	0.037 0.024	0.033 0.024
PE SME $\times$ 2022	0.025 0.026	0.026 0.026	-0.017** 0.007	-0.018** 0.007	-0.017*** 0.006	-0.018*** 0.006	-0.019*** 0.007	-0.019*** 0.007	-0.008 0.024	-0.006 0.024
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3007	2965	3007	2965	3012	2970	2972	2970	3012	2970

Table C3.1 reports the coefficients (β_i) from a difference-in-differences model for all dependent variables within the performance metrics. Respective standard errors (ϵ_i) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table C3.2: DiD Regressions on Financial Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Debt Contrib. / Assets		Equity Contrib. / Assets		Solvency		Cost of Liabilities	
PE SME $\times$ Crisis	0.018 (0.011)	0.022** (0.011)	0.001 (0.007)	-0.001 (0.007)	-0.028*** (0.007)	-0.032*** (0.007)	0.000 (0.001)	0.000 (0.001)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3001	2959	3001	2959	3012	2970	2956	2920
P-Value	0.118	0.049	0.896	0.945	0.000	0.000	0.780	0.749
R-squared	0.008	0.019	0.010	0.022	0.010	0.029	0.008	0.008

Panel B: Year-by-Year

PE SME $\times$ 2020	0.061*** 0.015	0.063*** 0.015	0.014 0.009	0.013 0.009	-0.015 0.010	-0.015 0.010	-0.001 0.001	-0.001 0.001
PE SME $\times$ 2021	-0.009 0.015	-0.008 0.015	-0.008 0.009	-0.011 0.009	-0.014 0.010	-0.018* 0.010	-0.001 0.001	-0.001 0.001
PE SME $\times$ 2022	-0.020 0.015	-0.016 0.015	-0.004 0.009	-0.003 0.009	-0.021** 0.010	-0.025*** 0.010	0.001 0.001	0.001 0.001
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	3001	2959	3001	2959	3012	2970	2956	2920

Table C3.2 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within financial engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

Table C3.3: DiD Regressions on Operational Engineering

Panel A: Crisis Period

	(1)	(2)	(3)	(4)	(5)	(6)
	Investments/Assets		Cost/Sales		WC/Assets	
PE SME $\times$ Crisis	0.008 (0.012)	0.008 (0.012)	0.011** (0.005)	0.011** (0.005)	-0.006 (0.008)	-0.009 (0.008)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	2936	2929	2960	2960	3012	2970
P-Value	0.538	0.501	0.020	0.015	0.497	0.258
R-squared	0.004	0.006	0.011	0.019	0.002	0.007

Panel B: Year-by-Year

PE SME $\times$ 2020	0.061*** 0.016	0.062*** 0.016	0.006 0.006	0.006 0.006	0.014 0.011	0.013 0.011
PE SME $\times$ 2021	-0.015 0.016	-0.015 0.016	-0.003 0.006	-0.003 0.006	-0.003 0.011	-0.004 0.011
PE SME $\times$ 2022	-0.033** 0.016	-0.033** 0.016	0.016*** 0.006	0.017*** 0.006	-0.022** 0.011	-0.025** 0.011
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Observations	2936	2929	2960	2960	3012	2970

Table C3.3 reports the coefficients (β_1) from a difference-in-differences model for all dependent variables within operational engineering. Respective standard errors (ϵ_{it}) are provided in parentheses below the coefficients.

Odd-numbered columns indicate coefficients without the inclusion of control variables, while even-numbered columns are an augmented model including control variables. All estimates include firm fixed effects and year fixed effects. Panel A indicates the baseline model for equation 1, while panel B presents a year-by-year model resembling equations 2 to 4. Values are winsorized to the 2% level to remove any influences from extreme outliers. Statistical significance levels are denoted as * for the 10% level, ** for the 5% level, and *** at the 1% level.

AI Disclosure:

AI was used in this study to provide us feedback on our theories and general arguments made in the text. Some recommendations regarding the structure of the paragraphs was also provided by AI.