Private equity financing & firm productivity

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Abstract

We study the impact of private equity funding and ownership on firm level productivity using a comprehensive dataset of private equity transactions from the U.K.
We outline the mechanisms through which private equity, as active owners, can build resilience and drive productivity growth in their portfolio firms. We find that, in comparison to a control group, private equity target firms enjoy a statistically significant productivity boost after acquisition. Our analysis suggest that this beneficial productivity effect persists even after the private equity fund exits the firm. We find statistically significant increases in employment and capital expenditures in target firms, in comparison to the control group, supporting the view that private equity unlocks the growth potential of firms. Moreover, our analysis suggests that target firm productivity may be more resilient during times of major disruptive episodes such as the Global Financial Crisis and the COVID-19 pandemic.

1 Introduction

Private equity (PE) is a source of capital that has been raised outside of public equity markets to buy out an equity stake in a company. Private equity funds are specialized vehicles which raise capital from institutional investors to take majority control of companies, often using considerable amounts of debt financing. They are distinctive in terms of i) structure, as they typically have a finite fund lifetime–usually ten years– and ii) in terms of strategy, as they typically acquire majority stakes, and are active investors in that they usually take board seats and often replace senior management personnel. The private equity industry has experienced significant growth since the 1980s.

In the United Kingdom (UK) (the focus of our study), private equity investment in 2022 represented about 1% of gross domestic product (GDP), according to data from Invest Europe. In line with these numbers, the British Private Equity & Venture Capital Association (BVCA) estimate that in 2023, PE-backed companies generate £137bn of GDP, and employ approximately 1.9 million workers (BVCA (2023)). This represents approximately 6% of the total employment of workers aged 16-64, based on data taken from the Office for National Statistics (ONS). In the UK, private equity firms predominantly invest in mature companies (providing growth finance) or acquire established companies (buyouts) with the aim of implementing value creation strategies by exploiting growth opportunities and providing investment capital to realize efficiency improvements.

Although UK financial markets are well developed, small and medium enterprises (SMEs) are subject to severe credit constraints. According to a report by BVA BDRC (2018)[1], 25% of small firms that apply to banks have their loan applications rejected and 6 in 10 would-be-borrowers choose to inject personal funds. Public equity and debt markets are normally accessible by the very large and established companies and after the Global Financial Crisis bank lending has retracted from the SME market segment as banks sought to recapitalize balance sheets. SMEs are subject to tighter credit constraints due to information opacity

[1] BVA BDRC SME Finance Monitor 2018 Q4

and are more dependent on bank financing (Gertler and Hubbard (1988)). A recent study by Chen and Lee (2023) using cross country firm level data –including the U.K.– provides strong evidence linking SMEs credit vulnerability with weak productivity growth in comparison to larger firms in the aftermath of the Global Financial Crisis. Similarly, Besley and Van Reenen (2020) report that as much as half of the decline in productivity in 2008 and 20% of the gap between actual and potential productivity (2008 to 2013) can be attributed to heightened risk perceptions by banks. In the current high interest rate environment, SMEs are likely to face more expensive credit, and tougher access to finance, if at all. Private equity, therefore, provides an alternative external source of finance which may ease financing constraints, especially for innovative SMEs with a high growth potential. To the extent that private equity is directed to high marginal value of capital companies, it may improve capital re-allocation towards more productive uses and consequently contribute positively to aggregate productivity.

However, a key aspect of private equity buy-outs is the use of debt. Many PE buyouts are leveraged, meaning that investor equity is combined with debt (or convertible debt) in order to purchase a target company. After acquisition, that debt becomes a liability of the purchased company. The use of debt has raised concerns in both policy and academic circles, since a significant increase in debt can contribute to the financial fragility of the target company and increase its probability of default during economic downturns. However, at the same time, the increase in debt may confer other benefits. First, it allows the company to access debt markets that would otherwise be inaccessible and pursue profitable investment projects[2]; second, systematic interest payments on debt can alleviate the free cash flow problem, whereby, company managers invest resources in negative net present value projects (Jensen (1986)). On the other hand, poor selection and structuring of deals during pre-crisis boom periods–during which valuations are high and credit conditions relaxed–may heighten

[2]Indeed, PE investors often have large networks of lenders and can enjoy bargaining power from repeated interactions, allowing them obtain lower borrowing rates (Ivashina and Kovner (2011), Bernstein et al. (2019)).

the risk of future distress when the economic cycle turns, exacerbating cutbacks in investment and employment. Short-sighted investors looking for a quick return could therefore, upon exiting, leave target companies at an increased risk of distress.

To date a body of literature has examined the effect of private equity ownership on a range of target company outcomes including (but not limited to) profitability and operating performance (Kaplan (1989), Guo et al. (2011), Cohn et al. (2014), Fracassi et al. (2022)), employment (Boucly et al. (2011), Lerner et al. (2019)), productivity (Harris et al. (2005), Davis et al. (2014)), innovation (Lerner et al. (2011), Amess et al. (2016)), exporting (Lavery et al. (2021), Wilson et al. (2022b)), financial distress (Thomas (2010), Wilson and Wright (2013), Hotchkiss et al. (2021)) and resilience to economic crisis (Wilson et al. (2012), Bernstein et al. (2019)). In this paper, we narrow our focus on firm-level productivity. We construct and analyze a comprehensive dataset that tracks all private equity acquisitions of public and private companies–from S&P Capital IQ and Pitchbook–in the UK from 2000 to 2021 with company level financial accounts from FAME database, published by Bureau Van Dijk Electronic Publishing.

We analyse the dynamics of total factor productivity and labour productivity in private equity backed companies vis-a-vis a group of matched control companies that are comparable across several observables including age, size, profitability, leverage, and industry affiliation. We employ a difference-in-differences econometric methodology to estimate the magnitude of change in productivity in private equity backed companies following the year of the acquisition. Our main findings are as follows. First, we estimate a statistically significant productivity boost in PE backed companies relative to the control group. For total factor productivity this effect is estimated to be greater than 4% and for labour productivity it is estimated as large as 5%. The impact on productivity persists even after the PE fund exits the firm. This productivity improvement comes hand-in-hand with growth in capacity of the target companies in employment and capital and it is therefore unlikely to be the result of efficiency gains derived from cost cutting activities that slashes employment and/or

sales of capital. Finally, we examine the impact of PE ownership on productivity during the two major economic shocks of the last two decades, namely the Global Financial Crisis and the COVID-19 pandemic. Our findings suggest that PE backed firms suffered smaller productivity losses in comparison to the control group.

The rest of the paper is structured as follows: section 2 reviews the relevant literature and discusses the factors that motivate and enable PE portfolio firms to implement productivity improvements and build resilience; section 3 describes the data used in our empirical work; section 4 examines the firm specific factors that lead PE investors to buyout firms; section 5 examines the impact of PE ownership on productivity. Section 6 examines the persistence of the productivity effect; section 7 examines the effect of PE ownership on productivity during the the global financial crisis and the COVID-19 pandemic. Section 8 concludes and suggests avenues for future research questions.

2 Literature overview

2.1 Private Equity and Active Ownership

The work of Jensen (1986) provides an important theoretical foundation for an understanding of the private equity (buyout) model. The agency theory perspective has been applied usefully to explain how the private equity firm's active role as an investor (owner) drives performance changes in their acquired firms (see Kaplan and Schoar (2005), Acharya et al. (2013), Manigart and Wright (2013)). In these studies, the PE firm is seen as a principal in its governance relationship with the investee (buyout). The PE firm (GP) acts on behalf of its own fund investors (LPs) to discipline (through leverage) and incentivise (through targets and share ownership) the buyouts' management team (agents). This model is effective in achieving efficiencies and impacting performance. A recent development of this paradigm introduces a 'dual agency' framework, Meuleman et al. (2022). These authors suggest PE have a 'dual identity' (Pratt and Foreman (2000), Arcot et al. (2015)) acting both as principal

and agent in a buyout transaction. They argue that the PE firms act as an agent for the banks with whom they have strong relationships. For instance, a PE firm will frequently negotiate with banks to raise debt finance for their acquisitions and for capital expenditure within their portfolio firms. The banks that provide loan finance will monitor loan repayments and the credit risks amongst the portfolio of PE investment (Citron et al. (1997), Fang et al. (2013)). Thus, a portfolio firm under PE control will likely have better access to finance (and at lower cost), more flexibility and stronger banking relationships than similar private companies. Evidence on the portfolio firms' advantage in renegotiating finances with creditors during periods of financial difficulty is provided in Meuleman et al. (2022), Hotchkiss et al. (2021), Lavery and Wilson (2022a).

PE investors gain the experience to become sophisticated and often specialised investors. They undertake extensive and costly selection and screening processes of potential target acquisitions (Kaplan and Strömberg (2001), Kaplan and Strömberg (2004), Gompers et al. (2020)). PE firms assess the strengths and risks to identify the 'right' target firms with specific characteristics (Kaplan and Strömberg (2004), Dawson (2011), Gompers et al. (2016)). Wilson et al. (2022a) provide evidence from UK transactions which suggests PE firms target firms that are underperforming, undercapitalised and have lower (relative) levels of productivity, amongst other characteristics, thus providing opportunities for the investors to realise performance improvement, and growth, post investment. Indeed, PE investors are under short-term pressure to generate returns and hence choose targets where an increase in productivity can be achieved post investment via capital expenditure (capex) and operational expenditures (opex) on immediate process and product improvements.

Specifically, productivity improvements in any firm come through several channels: introducing and innovating new technologies and automation(s); increasing the skills set and motivation of employees (e.g., incentives, training, effective communication, culture of collaboration and teamwork), improving management process (e.g., credit management, supply-chain management) and management information systems (e.g., performance metrics); at-

tracting or developing managerial talent in key functions (e.g. marketing, exporting, product development, customer relationship management, financial management). Regularly evaluating performance, seeking stakeholder feedback, and adapting strategies to changing market or economic condition ensures ongoing productivity improvements and resilience. The PE firm, as an 'active investor' i.e., a majority shareholder often with board representation, has a close involvement in both strategy development and implementation, process improvement and the day-to-day monitoring of management post-buyout. Along with capital investment in the firm, PE investors bring financial, operational and a pool of managerial expertise along with the accumulated knowledge and the relationship networks gained from their previous and current experience of portfolio firms.

Some authors draw on resource-based theories of the firm (RBV) to develop hypotheses about PE ownership and company performance. In line with arguments put forward by RBV, PE firms would help their portfolio companies to develop products/services, grow sales and expand internationally by providing knowledge, expertise and networks. PE firms can be a source of distinctive skills and tacit knowledge (Castanias and Helfat (2001)) and can provide complementary resources and capabilities (Zahra and Filatotchev (2004)) that may be missing in the existing management teams of their portfolio companies and/or transfer this expertise across their portfolio firms. PE firms may be more skilled and competent in advising and monitoring roles that create such distinctive organisational capabilities (Barney et al. (2001)). Meuleman et al. (2009) argue that PE firms are considerably different in terms of their accumulated experience, specialisation, network and investment style. As a result, having PE investors active on the board can help portfolio companies to realise previously untapped productivity and growth opportunities.

2.2 Portfolio Firm Resilience

Empirical literature provides some evidence that private equity backed firms are more resilient in adverse economic conditions and crises. In terms of the analysis that follows, the

production function analyses how firms use inputs in the best combinations to maximise profits or to achieve production targets. In this context resilience is how well firms respond to events that disrupt critical inputs in terms of adjusting and reconfiguring resources to maintain optimal combinations. Firms that are quick to respond and adapt by taking various actions are likely to perform better. In the economics literature, resilience is conceptualised as how firms use resources as effectively as possible to reconstruct and recover when facing adversity (Rose (2004), Graveline and Gremont (2017), Dormady et al. (2019)).

Dormady et al. (2019) provide a theoretical framework for analysing resilience within production theory and distinguish eleven 'resilience tactics' which include resource isolation ('modifying a portion of business operations to run without a critical input') input substitution ('replacing a production input in short supply with another'), relocation ('moving some or all of the business activity to a new location, such shifting data from onsite to "cloud" storage'); import substitution ('importing needed production inputs when not available from the usual local or regional suppliers, including new contractual arrangements'), technological change ('improvising all or part of the production process without requiring a major investment expenditure') and improvements in management effectiveness ('improving business efficiency in the aftermath of a disaster (e.g., allowing for flexibility in business operations/procedures to minimize red tape during recovery, offering flexible working hours, minimizing reporting requirements or monitoring to facilitate more efficient or responsive operations') (see Table 1., Dormady et al. (2019) p4.).

Business resilience can be discussed within the framework of a related body of literature in strategic management (RBV) that refers to 'dynamic capabilities' (Teece et al. (1997)). Dynamic capability is defined as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. (1997)). Private equity-backed firms are often considered more resilient in crises because they instil a pro-active management approach and work closely with management teams to implement strategic changes and improve operational efficiency as part of their business

model. These features provide the capability to respond and adapt quickly to changing circumstances and/or crises. This can include injecting additional capital, providing access to debt financing, or leveraging their networks to restructure or secure new financing. The financial resources of PE firms and expertise in renegotiating finance can enable private equity-backed firms to manage cash flow challenges and weather economic downturns. On the operational side, PE firms can leverage accumulated expertise to identify cost-saving opportunities, restructure operations and optimize business processes. This operational agility allows private equity-backed firms to respond to difficult market conditions. Indeed, private equity firms often specialize in restructuring and turning around underperforming companies (Cohn et al. (2022), Wilson et al. (2022a)). This expertise, along with their networks and connections, becomes particularly valuable during times of crisis when companies may face financial distress or operational challenges.

2.3 Private Equity and Portfolio Firm Productivity

In early work on PE and productivity, Lichtenberg and Siegel (1990) investigate the post-buyout productivity of US plants in the 1980s and find that buyout targets are more productive relative to non-buyout plants in the three years following the buyout transaction. Harris et al. (2005) find that U.K. management buyout (MBO) plants are less productive than comparable plants before the transaction, consistent with recent evidence of PE funds targeting companies which are under-performing and consequently can add value (Cohn et al. (2022), Wilson et al. (2022a)). Their results imply that after being acquired, target companies experience a significant increase in total factor productivity, which they attribute to the outsourcing of production costs. Similarly, Amess (2003) finds that a sample of UK MBO targets from 1986 to 1997 experience between 4% and 7% higher technical efficiency in the four years following the buyout.

Wilson et al. (2012) investigate the impact of the global 2008-09 financial crisis on UK private equity-backed companies. Their results suggest that private equity ownership

cushioned the impact of the crisis on their target companies, documented by the positive differentials in both productivity and profitability between private equity-backed companies and comparable non-sponsored companies. This is consistent with other evidence on the resilience of PE target companies during the 2008-09 financial crisis (Bernstein et al. (2019)).

In a large-scale US study of over three thousand private equity deals from 1980 to 2005, Davis et al. (2014) conclude that aside from creating new jobs at a faster pace relative to control firms, private equity backed companies experience stronger productivity growth in the two year post-buyout period. Moreover, Davis et al. (2014), Lerner et al. (2019) provide further evidence that the overall productivity of target firms increases. Interestingly, productivity gains are found to be amplified when deals are executed in a tight credit market, suggesting that PE backed companies have access to finance during downturns.

Aldatmaz and Brown (2020) study the implications of PE for the global economy as a whole, studying private capital investment in a large global sample of country-industries. The well-established spillover literature in economics provides evidence that productivity spillovers exist within industries (see Blomström and Kokko (1998) for a review). In their analysis of the real economic impact of PE investment, their findings suggest that employment growth, profitability growth, and labour productivity growth all increase across public companies in an industry following PE investment into that industry. This aligns with the findings of Bernstein et al. (2017) who document that industries with previous PE investment grow faster in terms of employment and productivity and are less exposed to aggregate shocks.

3 Data and Methodology

3.1 Data

Private equity buyouts. Our data on PE buyouts comes from S&P Capital IQ and from Pitchbook, each of which have been widely used in recent PE literature. We take all PE

buyouts from 2000 to 2021, excluding venture capital/growth equity deals, follow-on rounds of financing of the same portfolio company by the same PE investor, and excluding bolt-on acquisitions.[3] We only include deals where there is a defined PE investor.

We take all relevant information, such as the transaction date, the name(s) and location(s) of the investor(s), the transaction value (if disclosed), and the type of buyout transaction. In order to identify how and when the private equity investor exits a deal in each case, we use a variety of resources. We use Capital IQ's merger & acquisition database to search for sales to trade buyers and sales to other private equity investors (secondary buyouts). We also use Factiva and manual searches of financial news for acquisitions, initial public offerings, and bankruptcies/liquidations involving the target firms.

Each stage of the analysis presented in this paper uses a different sample of PE buyouts, dependent upon what is being examined. The specific sample used is outlined in each section.

Firm financial accounts. To source companies' financial accounts, we use the FAME database, published by Bureau Van Dijk Electronic Publishing (BvDEP). This database sources historical accounts of companies in the UK from Companies House, the national UK register. The extent of the requirement to disclose financial information in the UK, however, varies with the size of the company. Smaller companies are allowed to file abridged accounts or micro-entity accounts[4]. Since the amount of information small firms disclose to Companies House (and hence in the FAME data set) can be very limited, some of these firms may not feature in our empirical analysis. We download companies' financial accounts (balance sheets and profit & loss statements) and other firm information (such as industry codes, location, date of incorporation) for all companies in the FAME database for 2001 through 2021. This initial FAME sample yields a panel data of over 250,000 UK-based firms over a 21 year period covering significant events including the global financial crisis and the

[3] A bolt-on acquisition is where a PE investor acquires a platform company, which then acquires (eg bolts on) other companies. As such, the PE investor does not invest in the company, but is acquired by a company which is already PE-owned.

[4] The thresholds for company size and the level of financial accounting disclosures in the UK are available at: https://www.gov.uk/government/publications/life-of-a-company-annual-requirements/life-of-a-company-part-1-accounts

COVID-19 pandemic.

The final step here is to then match target firms from our list of PE buyouts in Capital IQ and Pitchbook to the FAME database. We do so manually. An advantage of FAME in this case is that it tracks firms' prior names. If company names differ between our list of transactions from Pitchbook and FAME, we verify that we are tracking the correct company by cross-checking that information such as reported sales, total assets, and company address or website are consistent between the two sources. We also use Companies House in this respect.

3.2 Estimating Total Factor Productivity

To estimate total factor productivity (TFP) at the firm-year level, we follow Levinsohn and Petrin (2003). The estimation itself depends on the availability of certain firm variables being reported in company accounts. As mentioned above, smaller firms in the UK are not obliged to file full accounts, and so estimating TFP for these firms is often not possible.

The inputs used in the estimation method for TFP are outlined as follows, following recent studies which use similar data to ourselves (Eberhardt and Helmers (2019), Bournakis and Mallick (2018)). All monetary variables from FAME are expressed in thousands of pound sterling, and deflated using industry-level deflators from the Office for National Statistics (ONS). The appendix provides a technical overview of the Levinsohn and Petrin (2003) methodology.

Firm-level output is measured as value added. Value added is defined as sales less intermediate inputs, where intermediate inputs are calculated as the cost of sales plus administration expenses, less remuneration. The labour input is the number of full-time equivalent employees reported on an annual basis.[5]

As noted in Eberhardt and Helmers (2019), a flow measure of capital would be ideal in

[5]A relevant point to note is that PE investors often make changes to target firms' management teams after acquiring them, by bringing in new senior management (Lerner et al. (2012), Gompers et al. (2016), Gompers et al. (2023)). While our estimation of TFP accounts for labour quantity, it does not account for labour *quality*.

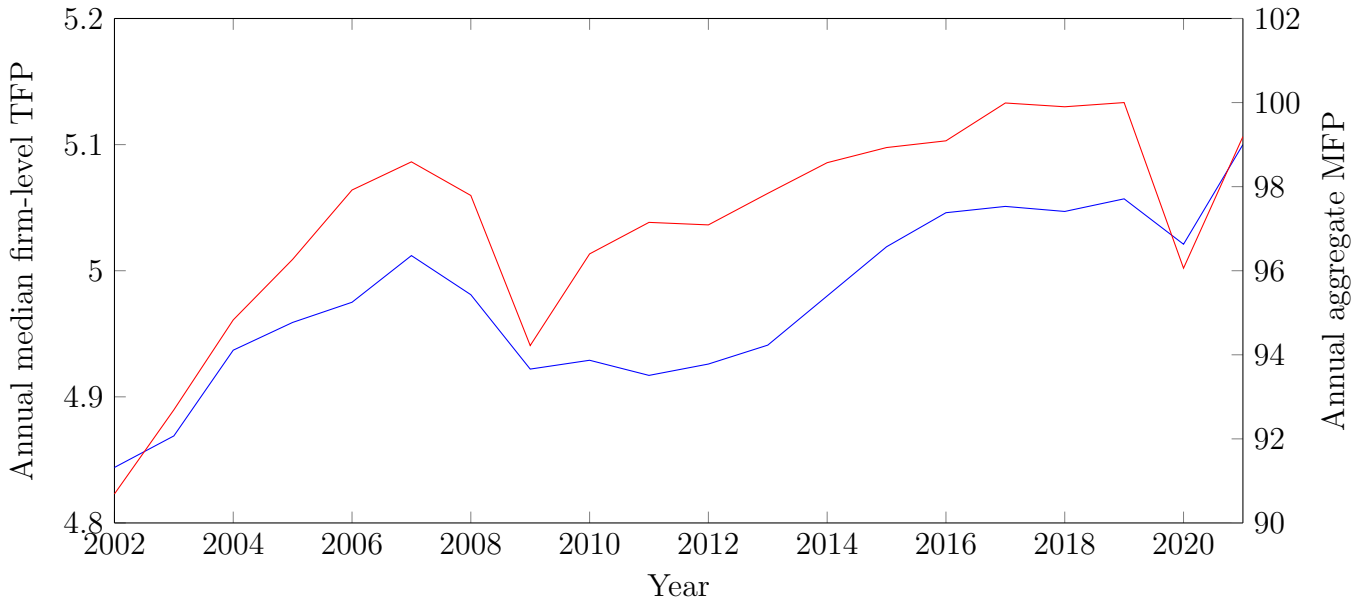
estimating TFP, but no such measure exists. As such, we use a measure of capital stock based on assets at book value. The capital input is measured as total tangible and intangible assets by book value, recorded annually. Tangible assets include land and buildings, fixtures and fittings, plants and vehicles, and other tangible assets. FAME defines intangible fixed assets as "All intangible assets such as formation expenses, research expenses, goodwill, development expenses and all other expenses with a long term effect". These assets are deflated at the industry level using ONS deflators.

We graph the median annual firm-level TFP of our sample in blue in Figure 1. Two declines in productivity of note occur following the global financial crisis in 2008/09, and during the COVID-19 pandemic in 2020. This pattern is consistent with annual total market sector UK productivity, which we also graph in Figure 1 in red, using data from the Office for National Statistics (ONS).[6]

[6]It is important to note that these two samples and methodologies are different. The ONS methodology for calculating MFP can be found here. The purpose of this exercise is simply to show that our firm-level TFP estimates broadly mirror what we see at the aggregate level in the UK over the same period.

Figure 1: UK productivity from 2002 to 2021

This figure graphs the median firm-level total factor productivity from 2002 to 2021 for our whole sample of firms in the FAME database (blue line), and the annual multi-factor productivity for the aggregate UK economy (red line). Data comes from FAME and the ONS. The ONS methodology for calculating MFP can be found here.



3.3 Summary statistics

Table 1, panel A, presents key summary statistics for the sample of over 250,000 firms in the FAME data set which is used in our analysis. The median firm is 13 years old, with a median firm-year employee count of 46, and sales of just under £8m. Roughly 75% of observations generate a positive EBITDA. The average ratio of debt-to-assets–a measure of leverage–is 21%, and the average return on assets, a measure of profitability, is 6%. In Panel B, we focus on UK PE targets, at the time of acquisition. These firms, as expected, as larger in size, in terms of assets, sales and employees, than the median UK firm, and are more profitable, with a higher degree of leverage.

Table 1: Summary statistics of the FAME data set

The below table reports summary statistics of the FAME data set of UK firms over the period 2001 to 2021. *Leverage* is total debt divided by total assets; *Return on assets* is net income divided by total assets; *EBITDA* is earnings before interest, tax, depreciation and amortization.

Variable	Firm-year observations	25%	50%	75%	Mean
Panel A: All firms					
Age	3,421,814	6	13	25	19
Employees	1,629,017	11	46	129	375
Total assets (£000s)	3,306,981	1,739	4,398	15,501	396,071
Sales (£000s)	1,620,095	2,106	7,769	23,504	97,771
EBITDA (£000s)	1,923,139	-1	351	1,658	11,539
Leverage	3,305,775	0.00	0.03	0.33	0.22
Return on assets	1,979,971	0.00	0.03	0.10	0.06
Panel B: PE-backed firms					
Age	3,007	7	15	25	19
Employees	2,420	64	156	414	593
Total assets (£000s)	2,733	6,123	16,950	47,582	113,984
Sales (£000s)	2,327	11,331	24,900	60,009	73,048
EBITDA (£000s)	2,403	610	2,560	6,957	7,156
Leverage	2,733	0.02	0.16	0.45	0.27
Return on assets	2,414	0.01	0.07	0.17	0.08

We then introduce the data on PE acquisition transactions. Figure 2 displays the number of PE buyouts of UK companies per year from 2000 to 2022, and funding raised by UK PE investors. Following the strong boom in the early to mid-2000s, the market experienced a large decline at the onset of the global financial crisis, and likewise during the COVID-19 pandemic. The year 2022 also saw a decline in deal-making due to a combination of factors including geopolitical tensions, supply chain disruptions, and rising interest rates. Table

2 reports the regional and industry distribution of PE buyouts. Unsurprisingly, London and South East-based companies attract considerably more private equity funding relative to other regions in the UK. This is consistent with other recent regional analysis of equity financing in the UK (Wilson et al. (2019), Bounds (2019)). Similarly, the industry distribution of target firms suggests a concentration of PE targets in consumer discretionary and industrial sectors, while other sectors such as information technology and health care are also attractive to PE investors.

Figure 2: PE buyouts and funds raised by year

The Figure shows the number of PE buyouts of UK companies, and the amount of funds (in £bn) raised by PE investors by year from 1990 to 2022. Data comes from S&P Capital IQ and Invest Europe (formerly the EVCA).

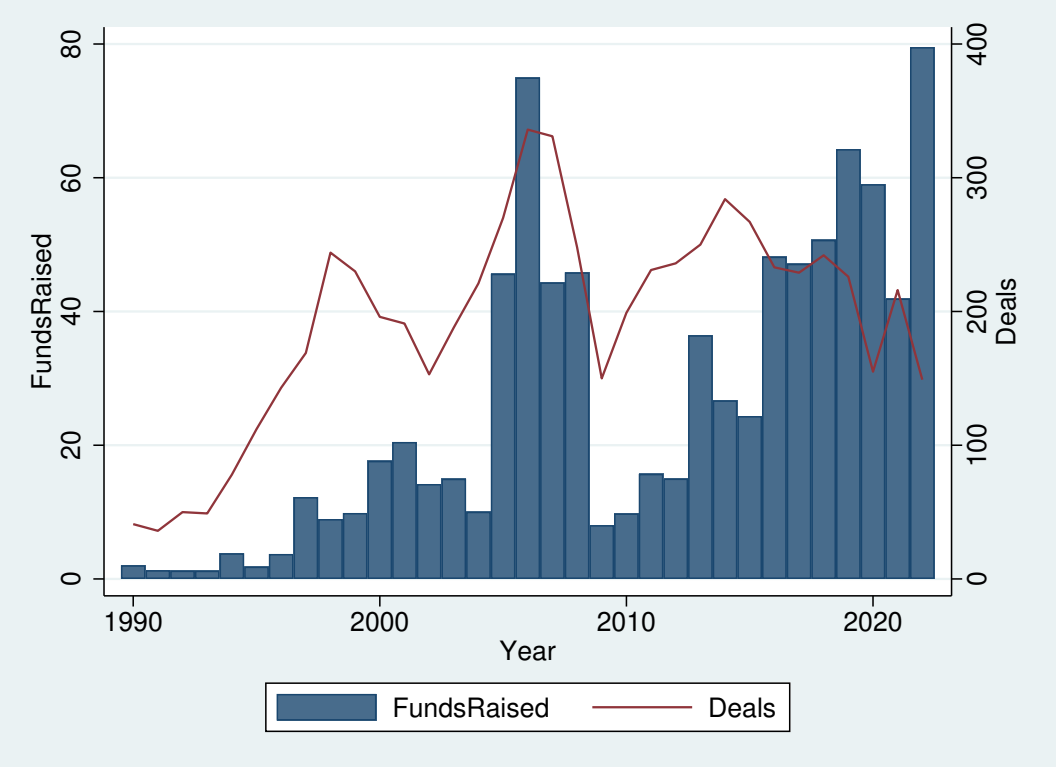


Table 2: Region and industry distribution of UK PE buyouts

The below table reports the region and industry breakdown of UK PE buyouts. Data comes from FAME and Capital IQ.

	Number of buyouts	% of total
Regions		
East Midlands	294	5.7
East of England	337	6.5
London	1,191	22.9
North East	113	2.2
North West	454	8.7
Northern Ireland	30	0.6
Scotland	200	3.9
South East	807	15.5
South West	181	3.5
Wales	105	2.0
West Midlands	398	7.7
Yorkshire & The Humber	391	7.5
Industries		
Communication services	376	7.2
Consumer discretionary	1,121	21.6
Consumer staples	238	4.6
Energy	74	1.4
Financials	425	8.2
Health care	380	7.3
Industrials	1,285	24.7
Information technology	610	11.7
Materials	198	3.8
Real estate	238	4.6
Utilities	187	3.6

Given that around 40% of PE deals occur in companies located in London and the South East, we then study whether target firms located in these regions which attract considerably

higher amounts of private capital investment differ from PE target firms located elsewhere in the UK.[7]

In Table 3 we display pre-buyout descriptive statistics of PE target firms, differentiating between those located in London and the South East, and those located in other UK regions. PE target firms in London and the South East are generally fairly similar to targets located elsewhere in the UK in terms of size, profitability, earnings, and investment. The main differences of note, and of statistical significance, are that target firms in London and the South East tend to be slightly younger, and are more productive. This echoes recent evidence on regional productivity levels in the UK (see for example Harris and Moffat (2022)).

[7]For a detailed analysis of the equity financing gap across UK regions see Wilson et al. (2019).

Table 3: PE targets in London & the South East vs other UK regions

The table reports pre-buyout characteristics of PE targets based in London & South East NUTS-1 regions against PE targets located in all other UK regions. *Sales growth* is the one year growth in sales. *EBIT* is earnings before interest and taxation, and *EBITDA* is earnings before interest, taxation, depreciation and amortization. *Capital investment* is the change in assets over the past year, plus depreciation, and is scaled by assets, and *total factor productivity* is estimated following Levinsohn & Petrin (2003). *ROA* is the return on assets (net income divided by total assets), and *EBITDA margin* is EBITDA divided by sales. *Interest coverage* is the ratio of EBIT to total interest expense. All ratios and growth rates are winsorized at the 2% level. Columns 7 and 8 show the difference in means and medians between LDNSE targets and targets in other regions. *** denotes statistical significance at the 1% level, ** denotes the 5% level, and * denotes the 10% level.

	LDNSE PE targets			Other regions PE targets			Difference	
Variable	N	Mean	Median	N	Mean	Median	Medians	Means
Firm characteristics								
Age	1,248	14	18	1,477	16	21	-2***	-3***
Employees	1,020	590	130	1,220	595	165	-5	-35*
Total assets	1,182	132,171	15,922	1,400	76,132	14,314	56,039	1,608
Sales	994	70,276	23,427	1,130	85,703	25,159	15,426	-1,732
Sales growth	893	0.16	0.11	1,020	0.15	0.09	0.01	0.02
EBITDA	1,017	7,620	2,467	1,175	8,409	2,644	-788	-177
ROA	1,021	0.07	0.07	1,179	0.08	0.08	-0.01	-0.01*
EBITDA margin	990	0.11	0.11	1,129	0.12	0.11	-0.01	0.00
Capital investment	1,016	0.21	0.21	1,239	0.20	0.19	0.01	0.02*
Sales per employee	928	347	132	1,093	306	127	41	5
Total factor productivity	717	5.57	5.61	926	5.49	5.48	0.08**	0.13***
Cash/total assets	1,180	0.17	0.09	1,394	0.15	0.08	0.02*	0.01
Debt/total assets	1,182	0.31	0.19	1,400	0.29	0.18	0.02	0.01
Debt/EBITDA	1,016	1.58	0.52	1,175	1.99	0.79	-0.31*	-0.27**
Interest coverage	773	114.15	7.51	970	120.59	10.34	-6.43	-2.83**

4 Who gets PE investment?

It is well known that PE investors do not approach firms at random, but follow an intense due diligence process in order to identify firms which meet their investment criteria. In a recent study, Cohn et al. (2022) conclude that, in the US, PE investors target firms which are under-performing and are dependent on external financing, but which have strong growth potential. In the UK, Wilson et al. (2019) and Wilson et al. (2022a) suggest that PE funds target larger and more established firms with a higher profitability and higher cash generation and are more likely to have prior borrowing activity. They note that targets have lower productivity suggesting investors seek opportunities where they can add value and realise performance improvements.

We undertake a probit analysis that can shed light on the firm specific factors that are the main drivers for the flow of PE funding. For this purpose we use our full FAME sample over the period 2000 to 2021. The estimates from the probit regressions are reported in Table 4. In column 1, we consider only balance sheet variables allowing us to study a much larger sample of firms given accounting disclosure requirements in the UK. In columns 2 and 3 we include firm specific variables from Profit and Loss (P/L) accounts. In column 3 we exclude total factor productivity which increases our sample given the data which is required to estimate the latter.

PE targets tend to be larger firms with a strong cash position highlighting their ability to service debt and the financial flexibility that cash reserves confer. Investors seem to be indifferent between older or younger firms. They have charges on their assets, an indication of prior borrowing activity.[8] When we include variables from firms' P/L accounts, we

[8]This data comes from the FAME database and is a dummy variable equal to one where there is a charge placed against a firms' assets in a given year, and zero otherwise. We can observe in FAME when there is a charge placed on the assets of a company, which is indicative of some form of lending. The data contains the names of the bank(s) (chargeholders) that have secured loans (charges) against each firm at a given point in time. According to Companies House, a charge is defined as the security, such as land, property or financial instruments a company provides as collateral for a loan. We observe the lender, and whether the charge has been settled, but not the loan amount or the interest rate paid on the loan. While technically the charge is the collateral for the loan, prior studies have used the term as a synonym for the loan itself and hence an indicator for the presence of a lending relationship or firm borrowing.

find that target firms have high coverage ratios, again indicating their ability to service the debt injection which can often accompany a PE buyout. They are profitable, have strong sales growth and have a lower distress risk as measured by the Altman's Z-score. Interestingly, TFP enters with a negative sign, indicating the PE funds target firms with room for productivity improvements. They are also more likely to have issued prior debt and have received equity financing. In sum, these findings are consistent with prior evidence of the determinants of PE target firm characteristics (Wilson et al. (2022a), Cohn et al. (2022)).

Table 4: Determinants of PE buyout targets

The table examines the determinants of buyout target firms. We use a probit model where the dependent variable is a dummy variable which equals one where a firm is acquired by a PE investor in that year, and zero otherwise. Specifically, we run the following model: $Prob(PE_{it} > 0) = \alpha_t + \theta X_{it} + \varepsilon_{it}$. α_t captures year fixed effects, and X_{it} denotes the explanatory variables in the model. Standard errors are clustered at the firm-level. *Asset intangibility* is the ratio of intangible assets to total assets, *charge on assets* is a dummy variable equal to one if a charge is placed against the firm's assets in a given year, and zero otherwise, and *return on assets* is net income divided by total assets. *Altman z-score* is the bankruptcy predictor following Altman (1968), and *sales growth* is the one-year growth in firm sales. *Interest coverage* is operating profit divided by interest expense, *debt issuance* is the overall change in debt, scaled by assets, *equity issuance* is the difference in total equity (shareholder value) over the past year, minus profit, scaled by assets, and lastly, *capital investment* is the change in fixed assets over the past year, plus depreciation, scaled by fixed assets.

	(1)	(2)	(3)
Age	0.075***	-0.016	0.018
	(0.007)	(0.019)	(0.015)
Total assets	0.083***	0.044**	0.076***
	(0.004)	(0.017)	(0.007)
Asset intangibility	3.270***	1.46***	2.041***
	(0.149)	(0.321)	(0.258)
Debt/assets	0.166**	-0.101	0.115
	(0.052)	(0.082)	(0.092)
Cash/assets	0.683***	0.286***	0.245***
	(0.035)	(0.114)	(0.091)
Charge on assets	1.138***	1.241***	1.208***
	(0.019)	(0.040)	(0.033)
Return on assets		2.497***	2.198***
		(0.306)	(0.219)
Altman z-score		0.082**	0.037*
		(0.032)	(0.020)
Total factor productivity		-0.071*	
		(0.032)	
Sales growth		0.098***	0.031*
		(0.033)	(0.015)
Retained earnings		-0.414	-0.509*
		(0.298)	(0.329)
Interest coverage		0.046***	0.048***
		(0.011)	(0.009)
Debt issuance		0.269**	0.217**
		(0.128)	(0.101)
Equity issuance		0.919***	0.689***
		(0.313)	(0.221)
Capital investment		-0.004	0.036
		(0.069)	(0.055)
Year FE	Yes	Yes	Yes
Observations	3,298,692	298,515	403,061

5 Does PE ownership boost the productivity of target firms post buyout?

5.1 A first look

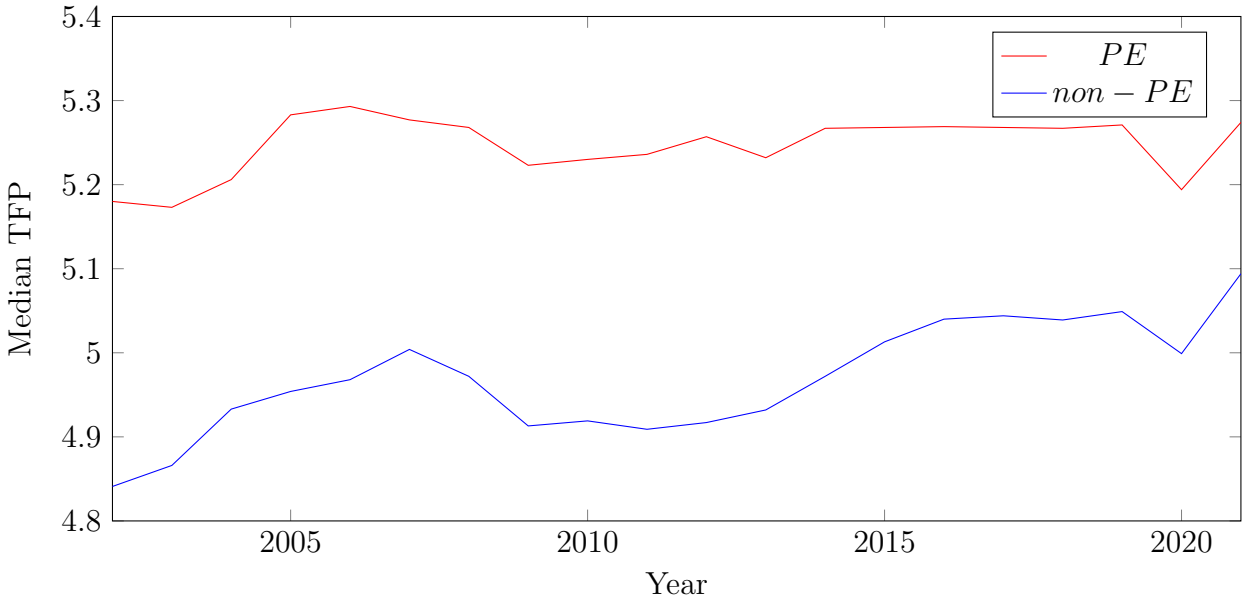
The first question we ask is whether PE ownership boosts the productivity of target firms post acquisition. By means of an initial insight, Figure 3 (panel A) displays the median TFP of all firms under PE ownership from 2002 to 2021, against the median TFP of all other firms in the FAME sample in the same year. The Figure suggests that PE-backed firms are more productive when compared against all other firms in the FAME sample. However, this may be due to selection bias: it is well-documented that PE investors do not select firms in which to invest at random (Wilson et al. (2022a), Cohn et al. (2022)), and section 4 above presented evidence to support this. Accordingly, we then refine our sample to compare firms under PE ownership to a carefully selected control group of non-PE-backed firms. We match firms which are PE-backed in a given year to non-PE-backed firms that are comparable in terms of industry, size, leverage, and profitability in that year. The results are displayed in panel B of Figure 3.[9] While the difference between PE-backed and matched firms' productivity narrows, the former group continues to outperform in terms of TFP in virtually all sample years. For example, in certain years in the sample, PE-backed firms are as much as 5% more productive in comparison to the control group.

[9]That is, if a firm is PE-owned for four years, it is matched against non-PE-backed firms in each of those four years.

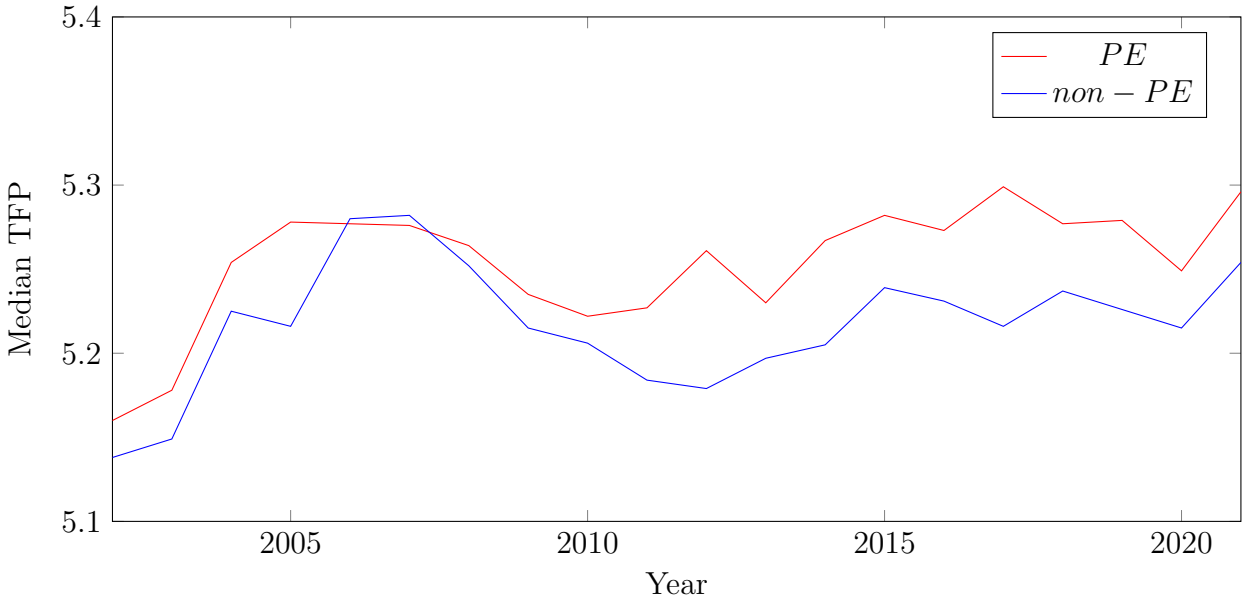
Figure 3: Median TFP over time: PE-backed versus non-PE-backed firms

This figure illustrates the median TFP over time for PE-backed companies against non-PE-backed companies. In panel A, we graph all firms under PE ownership against all non-PE-backed firms. In panel B, we reduce the comparison to firms which are PE-backed in a given year to a control group of non-PE-backed firms based on their industry, size, leverage, and profitability in that year.

Unmatched sample



Matched sample



5.2 Empirical methodology

In the empirical analysis we undertake in the remainder of the paper we follow a difference-in-differences (DiD) econometric approach. To investigate how PE ownership impacts target firm productivity, we would ideally compare PE-backed firms to firms which are identical in every way, other than that they are not PE-backed. In reality, this is, of course, impossible. Consequently, and following recent PE literature (Boucly et al. (2011), Bernstein et al. (2019), Cohn et al. (2021)), we use a difference-in-differences setting where we compare PE-backed firms to a matched set of control firms around the time of the PE buyout occurring.

To do so, requires the construction of a matched sample of PE-backed (treated) and non-PE-backed (control) firms. While in section 5.1 we match PE-backed firms to control firms in each year of their PE ownership period, in the following analysis we match PE-backed firms to control firms in the year prior to the former being acquired. Specifically, our matching requires that each control firm meets the following criteria: 1) it has the same two-digit SIC code as the treated PE-backed firm; 2) it has total assets in the pre-buyout year within a 50% bandwidth as the treated firm; 3) it has a leverage ratio (defined as total debt divided by total assets) within a 50% bandwidth in the pre-buyout year; 4) it has a return on assets within a 50% bandwidth in the pre-buyout year. We match each PE-backed firm with up to five control firms. If a target firm matches to more than five control firms based on this matching, we select the closest five based on the quadratic distance computed based on the variables we match on. This matching technique allows us to match 919 PE-backed firms to a total of 3,410 control firms.[10]

Table 5 reports descriptive statistics that speak to the quality of the matching. We present those for each of the PE backed and control groups and report *t-tests* for the difference

[10]In unreported tests, we present an alternative matching procedure where we include firm location as an additional matching criterion. The Nomenclature of Territorial Units for Statistics (NUTS) is a geocode standard from Eurostat for referencing the subdivisions of the UK. The 12 UK regions are: North East, North West, Yorkshire & the Humber, East Midlands, West Midlands, East of England, Greater London, South East, South West, Wales, Scotland, and Northern Ireland. This matching technique results in a sample size of 611 PE-backed firms and 1,588 control firms. Similarly, we reduce the matching bandwidths from 50% to 30%. With this smaller, more tightly-matched sample, our main findings remain unchanged.

in those statistics. Panel A shows descriptive statistics in the pre-transaction year, while Panel B shows growth rates. Across PE-backed and control groups, firms have very similar levelks of sales, cash, profitability, leverage, and productivity in the pre-buyout year. These differences are statistically insignificant. The only notable difference is that PE-backed companies have slightly larger sales than control firms, but this difference only persists at the 10% level implying only weak significance. Importantly, in panel B, we find that the differences in the growth rates between the two groups are not significantly different from zero across observables. Overall, the matching appears to be successfully in constructing two groups of firms which are similar in their observable characteristics and in their growth in the pre-buyout period.

Table 5: Pre-transaction descriptive statistics and growth rates for matched sample

The table reports pre-deal year descriptive statistics and one-year growth rates for PE-backed firms and matched control firms. *PE* refers to all PE-backed companies; *Control* refers to non-PE-backed firms, matched on their SIC code, total assets, ROA (net income/assets), and leverage (debt/assets) within a 50% bracket in the pre-deal year. *Return on assets* is net income divided by assets and *EBITDA margin* is EBITDA divided by sales. *TFP* is estimated following the Levinsohn and Petrin (2003) methodology and *Labour productivity* is value-added per employee. Ratios and growth rates are winsorized at the 2% level. *** denotes statistical significance at the 1% level, ** denotes the 5% level, and * denotes the 10% level.

	PE				Control				Difference	
Panel A: Pre-transaction descriptive statistics	N	Mean	Median	St.Dev	N	Mean	Median	St.Dev	Mean t-test	Median t-test
Age	916	21	16	20.00	3,402	20	16	20.21	1	0
Total assets	919	78,549	15,303	376,492	3,410	66,757	13,461	307,264	11,792	1,842
Sales	873	66,216	21,507	212,204	2,957	57,175	17,548	156,798	9,041*	3,959
Return on assets	919	0.07	0.07	0.15	3,410	0.07	0.07	0.13	0.00	0.00
EBITDA margin	873	0.12	0.11	0.19	2,955	0.13	0.10	0.24	-0.01	0.01
Debt/assets	919	0.35	0.26	0.32	3,410	0.36	0.27	0.31	-0.01	-0.01
Cash/assets	919	0.12	0.06	0.15	3,410	0.12	0.05	0.17	0.00	0.01
Total factor productivity	681	5.42	5.42	0.67	2,020	5.40	5.39	0.69	0.02	0.03
Labour productivity	829	231	127	444.98	2,570	264	155	622	-33*	-28*
Panel B: Pre-transaction growth rates	N	Mean	Median	SD	N	Mean	Median	SD	Mean	Median
Total assets	902	0.18	0.10	0.35	3,259	0.17	0.08	0.37	0.01	0.02
Sales	798	0.15	0.09	0.29	2,635	0.14	0.07	0.36	0.01	0.02*
Return on assets	864	0.02	-0.05	2.66	3,137	0.06	-0.04	2.82	-0.04	-0.01
EBITDA margin	797	0.07	0.00	1.52	2,634	0.09	0.00	1.41	-0.02	0.00
Debt/assets	834	0.36	-0.03	1.78	3,057	0.42	-0.02	1.93	-0.06	-0.01
Cash/assets	858	2.85	0.01	11.18	2,948	2.55	0.00	10.37	0.30	0.00
Total factor productivity	604	0.09	0.08	0.27	1,745	0.09	0.07	0.31	0.01	0.02
Labour productivity	752	0.04	0.04	0.20	2,273	0.06	0.04	0.25	0.02	0.00

Before proceeding with the formal estimation method, Figure 4 provides a visual representation of the evolution of firm-level TFP before and after buyouts for the matched sample of PE-backed and control firms. This is important given that out DiD analysis relies on the parallel trends assumption (see Imbens and Wooldridge (2009)).[11]

Figure 4 displays the α_t of the following equation:

$$TFP_{it} = \alpha_t + \alpha_i + \varepsilon_{it} \tag{5.1}$$

where TFP_{it} is total factor productivity for firm i at time t. α_t captures year fixed effects and α_i denotes firm fixed effects. We use the year before the buyout as the base period, and we normalize its corresponding coefficient to zero. We estimate the equation separately for both the PE-backed and matched control samples, with standard errors clustered at the firm level.

Figure 4 confirms that the evolution of firms' productivity in the matched sample is very similar in the pre-buyout period, which visually confirms the satisfaction of the parallel trends assumption and validates our empirical approach. After the buyout year we observe a material divergence in productivity, whereby PE-backed firms appear to outperform control firms. This offers prima facie evidence for the hypothesis that private equity ownership may impact in a beneficial way target firm productivity.

In our baseline DiD analysis, we estimate the following empirical model:

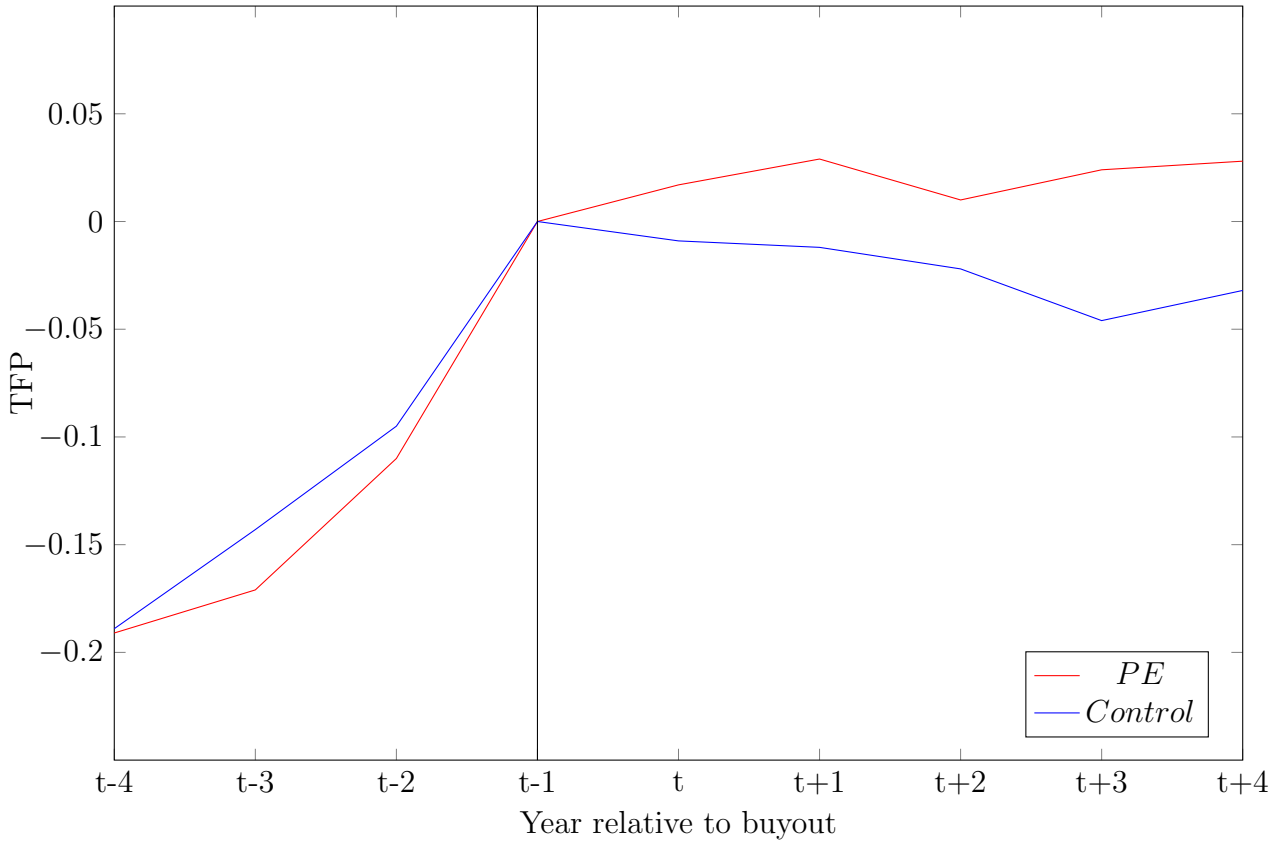
$$y_{it} = \alpha_t + \alpha_i + \beta_1(PE_i * Post_{it}) + \beta_2 Post_{it} + \theta X_i * Post_{it} + \varepsilon_{it} \tag{5.2}$$

where the dependent variable y_{it} denotes total factor productivity, or labour productivity (measured as value added per employee). PE_i is a dummy variable that equals one for PE-backed companies, and zero for the control group. $Post_{it}$ is a dummy variable that equals

[11] This assumption implies, that, in this context, the average change in an outcome variable for firms in the treated group (PE-backed), would be identical to the average change in the same outcome variable in the control group.

Figure 4: The effect of PE ownership on firm productivity post buyout

This figure shows the evolution of productivity for the sample of matched PE-backed and control firms from before to after the PE-backed sample undergoing the buyout. Specifically, the graphs shows the α_t of the following equation: $y_{it} = \alpha_t + \alpha_i + \varepsilon_{it}$. α_t captures year fixed effects, and α_i captures firm fixed effects. y_{it} is total factor productivity. The year prior to the buyout is the reference period and its corresponding coefficient is normalized to zero. Standard errors are clustered at the firm-level.



one after the buyout, and zero before. For control firms, $Post_{it}$ equals one when the matched target firm corresponding to the control has been acquired, and zero before. Following the PE literature (see for example, Cohn et al. (2021)), we include four years either side of the transaction occurring.[12] We include year fixed effects, α_t, and firm fixed effects α_i. We cluster standard errors at the firm level.

We also construct several firm specific variables to control for pre buyout heterogeneity in firm-level characteristics (captured by vector X_i in equation 5.2). In particular, following Bernstein et al. (2019), we control for firm age, size (total assets), sales growth, leverage, and profitability (ROA). These controls help to alleviate any concerns regarding any differences between the treated and control samples in the pre buyout period. We take these control variables in the pre transaction year and interact them with the $Post_{it}$ dummy variable in order to protect against any endogeneity concerns. The main coefficient of interest is β_1, which captures the estimated change in private equity targets' productivity from before to after the buyout, relative to the control group.

5.3 Results

The results of estimating equation 5.2 are reported in Table 6. We focus on the sign and significance of the interaction term ($PE_i * Post_{it}$), which measures whether private equity-backed firms are more likely to have systematically different (average) productivity in the post-buyout period relative to the control group. We find a positive and highly significant impact of PE ownership on target firm productivity. The point estimates point to significant increases in both measures of productivity. They indicate an average increase in TFP (labour) productivity of approximately 4 (5) percentage points respectively. This finding is robust to the inclusion of various fixed effects, and to a battery of firm-level control variables.

[12] If we narrow our sample to a three year window either side of the buyout, or increase the window to five years, our results are similar. Moreover, given the data requirements necessary to estimate TFP at the firm-year level, naturally, there are firm-year observations in our data set where TFP is missing. We rerun the models on the sample of only complete cases e.g., firms where TFP is present for every year from t-4 to t+4 (where year t is the year of the buyout) for the given firm. While this reduces the number of observations of the sample by around 50%, the results remain intact.

These findings align with evidence from earlier studies from the UK and the US (Lichtenberg and Siegel (1990), Amess (2003), Harris et al. (2005), Davis et al. (2014)).

Table 6: The impact of PE ownership on productivity

We estimate all specifications using a difference-in-differences estimator. The dependent variables are total factor productivity (columns 1-2), and labour productivity, measured as value added per employee, (columns 3-4). PE is a dummy variable equal to 1 for PE-backed firms and 0 for control firms. Post is a dummy variable equal to 1 for post-buyout years, and 0 otherwise. Columns 2 and 4 include firm-level controls taken in the pre buyout year and are interacted with the Post dummy. Firm controls include age, size, leverage, profitability (ROA), and growth. Standard errors are clustered at the firm-level. *** denotes statistical significance at the 1% level, ** denotes the 5% level, and * denotes the 10% level.

	TFP		Labour productivity	
	(1)	(2)	(3)	(4)
PE*Post	0.045***	0.042***	0.053**	0.056**
	(0.010)	(0.011)	(0.023)	(0.024)
Post	-0.032***	-0.037	-0.041***	0.032
	(0.011)	(0.036)	(0.015)	(0.030)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes
Observations	20,562	20,562	26,112	26,112

While the estimates in Table 6 measure the average change in productivity from before to after buyout, they do not indicate the timing of these changes. We therefore examine the timing of the change in productivity after a buyout by estimating the following regression:

$$y_{it} = \alpha_t + \alpha_i + \Sigma\beta_k(YearRelBuyout_{it}) + \Sigma\gamma_k(PE_i * YearRelBuyout_{it}) + \varepsilon_{it} \quad (5.3)$$

where, $k = -4,-3,-2,0,1,2,3,4$, and denotes the number of years before the year of the buyout (year 0), and the number of years after the year of the buyout. The year immediately

before the year of the buyout (-1) is missing because this is the year we match treated and control firms. The coefficient on γ_k captures the difference between firm productivity in year k relative to the buyout year and productivity in the pre-buyout year. If our model measured the impact of PE ownership on post-buyout productivity (and not differential trends in the two sets of firms) then we would expect statistically significant coefficients on γ_k to appear only in the post-buyout period.

Table 7 reports the estimates from equation 5.3. The estimated coefficients capture the evolution of target firm productivity relative to the control group each year in a window which comprises four years before, up to year -2, and 4 years after the buyout.[13] The patterns we see in columns 1 and 2, for each measure of productivity, align with the evidence in Figure 4. That is, there appears to be no significant difference between treated and control firms' productivity in the pre-buyout period. The interaction terms for the post buyout period, $YearRelBuyout_K * PE$, imply that TFP and labour productivity at PE target firms increase considerably compared to the control group in the post-buyout period. The interesting finding from the Table is the persistence of the uplift in total factor productivity, even four years following the buy-out, suggesting the PE ownership confers significant changes in firms' performance. A hypothesis that has has received considerable merit as a partial explanation of the enhanced productivity is the significant improvement of management practices brought about by PE funds. Bloom et al. (2015), provide evidence from a double-blind cross country survey. They suggest that among different ownership types examined, PE have significantly better management practices that relate to better alignment of performance related incentives, monitoring and operating improvements and delegation of authority. Our findings also relate to Biesinger et al. (2020) who argues that productivity gains may increase in the long run as operational and organizational changes may take time to implement. We view our findings as consistent with the hypothesis that PE's superior management practices and the organizational change–and consequently better allocation of existing resources–they

[13]To save space, we only report the coefficients on PE*YearRelBuyout.

bring about are likely to be the main driving force behind the productivity improvements we estimate.

Table 7: The evolution of productivity after buyouts

We estimate all specifications using a difference-in-differences estimator. The dependent variables are total factor productivity (column 1), and labour productivity, measured as value added per employee, (column 2). PE is a dummy variable equal to 1 for PE-backed firms and 0 for control firms. YearRelBuyout is the year relative to the buyout. The year prior to the buyout year is excluded. Standard errors are clustered at the firm-level. *** denotes statistical significance at the 1% level, ** denotes the 5% level, and * denotes the 10% level.

	TFP	Labour productivity
	(1)	(2)
PE*YearRelBuyout-4	-0.003	-0.014
	(0.023)	(0.018)
PE*YearRelBuyout-3	-0.035	-0.020
	(0.025)	(0.018)
PE*YearRelBuyout-2	0.005	-0.009
	(0.020)	(0.010)
PE*YearRelBuyout0	0.041	0.032*
	(0.051)	(0.021)
PE*YearRelBuyout1	0.042**	0.039**
	(0.015)	(0.015)
PE*YearRelBuyout2	0.029*	0.046***
	(0.019)	(0.017)
PE*YearRelBuyout3	0.078***	0.035**
	(0.028)	(0.018)
PE*YearRelBuyout4	0.082***	0.073***
	(0.030)	(0.022)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	20,562	26,112

5.4 Does PE ownership unlock growth potential?

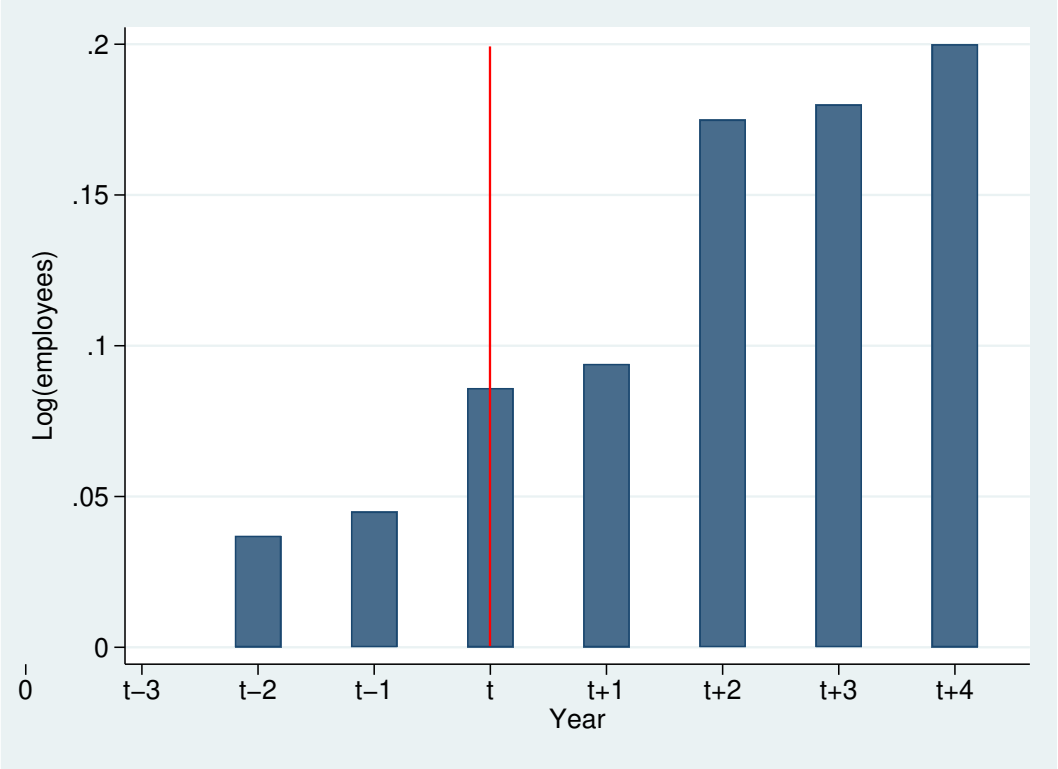
Having identified a positive and strongly significant impact of PE ownership on firm productivity, we study how firm dynamics in employment and capital expenditure (CAPEX) evolve during PE buyouts. Our goal is to explore if the positive effect in productivity estimated above is the result of unlocking growth potential. A critique of PE is that they realise efficiency gains by divesting and reducing employee headcount. We begin with a visual inspection of employment and CAPEX dynamics following buyouts. These are displayed in Figures 5 and 6. Figure 5 shows the excess employment growth relative to the control group, suggesting a 20% increase in employment four years after the buyout. Almost half of this effect takes place in the year immediately following the buyout. Similarly, Figure 6 suggests an over 40% increase in CAPEX two years following the buyout, with nearly all of the effect occurring in the two years immediately following the buyout. These statistics present strong evidence that PE backed firms significantly invest in firm capacity after the buyout. The growth in capacity is consistent with the view that, by relaxing financing constraints, PE unlocks the growth potential of target companies.

To complement the descriptive visuals above, Table 8 presents estimates from equation 5.2 where the dependent variable now being the logarithm of the number of employees, and capital investment rate, defined as the change in fixed assets over the past year, plus depreciation, and scaled by total assets. The point estimates indicate an average increase in post-buyout employment of around 16 percentage points relative to the match control sample (columns 1 and 2). As before, this finding is robust to the inclusion of various fixed effects, and to a battery of firm-level control variables. The point estimates further suggest an investment rate increase by around 2 percentage points relative to the control group (columns 3 and 4). The increases in employment and capital investment rates are significant at the 1% and 5% significance level. These findings suggest that productivity improvements in PE backed firms goes hand-in-hand with growth in capacity relative to the control group. This finding suggest that PE brings about organic growth and the productivity gain we

estimate is unlikely to be the result of dis-investment or employee redundancies.[14]

Figure 5: Mean-adjusted increase in employment around the buyout

Following Boucly et al. (2011), for each deal in our sample, let t be then number of years since the buyout. For each t and each buyout target, we first compute the change in employment between 3 years before the deal (t=3) and t. For each buyout target, we then take all control firms and compute the mean change in employment between 3 and t. We then compute the difference between the employment change of the target and the mean employment change of the control firms: this is the adjusted change of employment at the target level. The figure plots the average adjusted change in employment for t=2, 1, 0, 1, 2, 3 and 4 and across all targets in our sample.



[14]Importantly, our findings hold when we control for buy-and-build deals, where employment may increase mechanically as the PE target firms simply acquires other firms during the PE holding period (see Hammer et al. (2017)).

Figure 6: Mean-adjusted increase in capex around the buyout

Following Boucly et al. (2011), for each deal in our sample, let t be then number of years since the buyout. For each t and each buyout target, we first compute the change in capex between 3 years before the deal (t=3) and t. For each buyout target, we then take all control firms and compute the mean change in capex between 3 and t. We then compute the difference between the capex change of the target and the mean capex change of the control firms: this is the adjusted change of capex at the target level. The figure plots the average adjusted change in capex for t=2, 1, 0, 1, 2, 3 and 4 and across all targets in our sample.

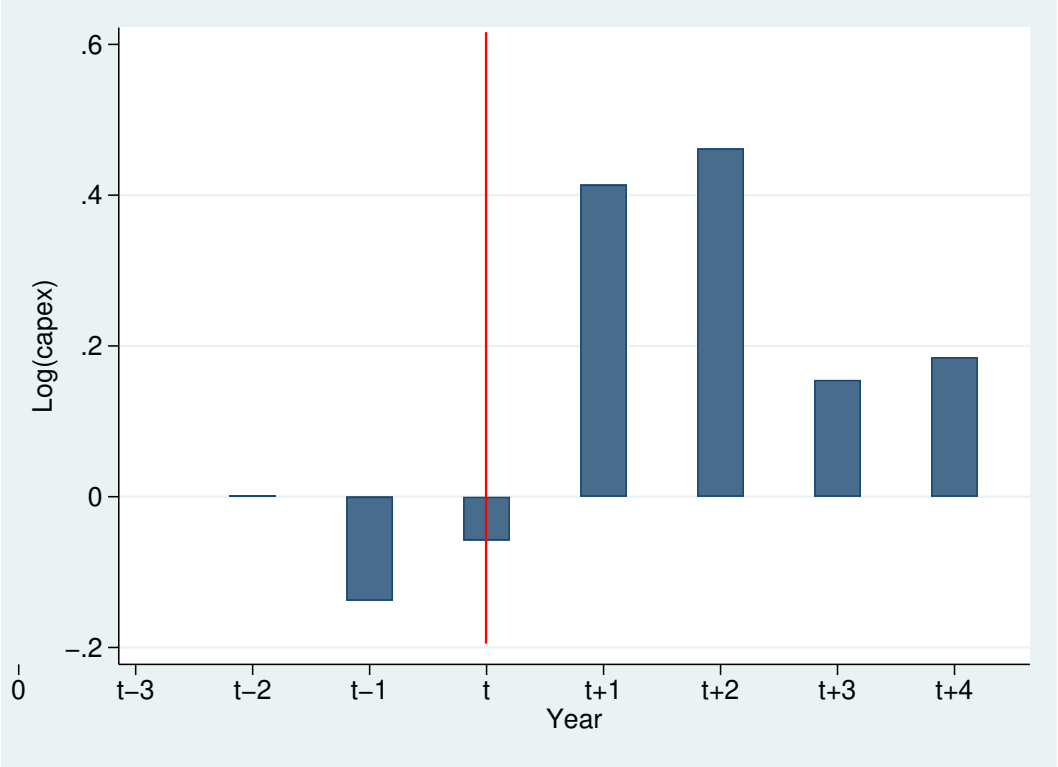


Table 8: The impact of PE ownership on employment and investment

We estimate all specifications using a difference-in-differences estimator. The dependent variables are the logarithm of the number of employees (columns 1 and 2), and capex investment, as measured by the change in fixed assets over the past year plus any depreciation for the year, and scaled by assets (columns 3-4). PE is a dummy variable equal to 1 for PE-backed firms and 0 for control firms. Post is a dummy variable equal to 1 for post-buyout years, and 0 otherwise. Columns 2 and 4 include firm-level controls taken in the pre buyout year and are interacted with the Post dummy. Firm controls include age, size, leverage, profitability (ROA), and growth. Standard errors are clustered at the firm-level. *** denotes statistical significance at the 1% level, ** denotes the 5% level, and * denotes the 10% level.

	Employment		Capital investment rate	
	(1)	(2)	(3)	(4)
PE*Post	0.161***	0.163***	0.021**	0.024**
	(0.032)	(0.033)	(0.007)	(0.009)
Post	-0.042***	0.008	-0.027***	-0.037*
	(0.014)	(0.052)	(0.008)	(0.020)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes
Observations	28,382	28,382	27,731	27,731

6 Does the productivity effect persist once the PE investor has exited the firm?

In this section we examine the persistence of the productivity impact we have identified above. Specifically, we are interested to understand whether this impact differs during the holding period of PE ownership and in the period after the PE investor(s) has exited the target firm. This section draws from Lavery and Wilson (2022b) and uses a comprehensive UK sample of PE buyouts. We first need to make some adjustments to our sample of PE buyouts. We include only realized deals (i.e where the PE investor has exited the firm) as we study how target firms perform after the PE investor has exited the firm. We also exclude

deals exited via a secondary buyout, where the post-exit period is simply the same firm under PE ownership of another PE investor. This leaves us with a sample of 1,906 PE buyouts where an exit has been experienced, but includes no exits via a secondary buyout. Lastly, we exclude deals exited after 2017, ensuring that we have at least four years of post-exit accounting data for all of our buyout target firms. This leaves us with a final sample of 1,244 PE deals for which we have accounting data in both the PE holding period and in the post exit period.[15]

We proceed to a formal DiD regression analysis and estimate the following empirical model:

$$y_{it} = \alpha_t + \alpha_i + \beta_1(PE_i * Post_{it}) + \beta_2(Post_{it}) + \beta_3(PE_i * Post_{it} * Exit_{it}) + \beta_4(Post_{it} * Exit_{it}) + \varepsilon_{it} \tag{6.1}$$

Where PE_i takes the value one for all private equity-backed companies and zero for the control group. $Post_{it}$ is equal to one after the target firm is acquired by a PE investor. $Exit_{it}$ is a dummy variable equal to one for years after the PE investor has exited the target company. For the control firms, $Post_{it}$ equals one when the target corresponding to the matched control firm has undergone the buyout, and zero before. Similarly, $Exit_{it}$ is equal to one for years after the PE investor has exited the corresponding target company. We track portfolio companies of realized buyouts up to five years post-exit. We can therefore study whether the impact of PE ownership on firm performance is only experienced during the holding period, or whether it persists once the PE investor has exited the firm. In all specifications we include firm fixed effects (α_i) and year fixed effects (α_t), and cluster standard errors at the firm level.

The coefficient on β_3 will capture any incremental post-exit impact on PE-backed com-

[15] In order to study the long run implications of PE ownership on firm productivity, we compare PE-backed firms to an appropriate matched sample. We follow the same methodology to form the matched sample as in the previous section. This yields a sample of 783 PE-backed firms and 3,467 control firms. Summary statistics from the matched sample are provided in Table 2 in the appendix.

panies relative to control companies, in addition to the effect of PE ownership on firm performance during the PE holding period (β_1). If the sign of the β_3 is inconsistent with the sign on β_1, the effect on target firm performance does not persist in the post-exit period. To test this persistence effect, we report the linear combination of $\beta_1 + \beta_3$, which compares the effect during the holding period and the post-exit effect to the pre-buyout productivity.

6.1 Results

The results from the estimation of equation 6.1 are presented in Table 9. As before we present results for both total factor and labour productivity. We report the coefficients for β_1, which measures the average effect of PE ownership on target firm performance during the holding period, β_3, which measures the average effect in the years following the exit, and the linear combination of $\beta_1 + \beta_3$, which measures the longer run effect of PE ownership. We do not discuss the estimated coefficient, β_1, the magnitude of which is qualitatively consistent with the results reported in section 5 above. In columns 3 and 4, the estimated coefficient for β_3 suggests a positive effect, however, this is not significant at conventional significance levels. The sum of estimated coefficients in columns 5 and 6 suggest that the positive effects of PE ownership on total factor productivity and labour productivity do in fact persist beyond the exit period. Relative to the matched control firms and relative to the pre-buyout period, our results suggest that PE-backed firms are more productive beyond the short term, following the investors' exit.

These findings are important as they highlight the long-run implications of PE ownership on target firms. Empirical studies examining the impact of PE ownership on target firms has largely focused on how firms perform within the holding period by the PE investor(s), which can extend to ten years but is typically 3-6 years, on average. Given that PE investors are financial investors motivated by the return on capital, a common criticism of private equity is that it fosters short-termism as PE investors are focused on maximising returns before exiting (Stiles (2021)). A counter-argument, however, is that the target company itself

receiving PE investment will also be concerned with it's long-run performance, beyond the PE holding period, particularly if the CEO or management team are retained after the PE investor exits. The findings in this section indicate that the positive impact of PE ownership on target firm productivity persists even after the PE investor(s) exit the firm.

Table 9: Post-exit performance of portfolio firms

We estimate all specifications using difference-in-differences estimators. *PE* is a dummy variable equal to 1 for PE-backed firms and 0 for control firms. *Post* is a dummy variable equal to 1 for post-buyout years, and 0 otherwise. *Exit* is a dummy variable equal to 1 for years after the PE investor has exited the target company. *** denotes statistical significance at the 1% level, ** denotes the 5% level, and * denotes the 10% level.

	Ownership effect β_1: PE*Post		Persistence effect β_3: PE*Post*Exit		Long run effect $\beta_1 + \beta_3$		
	coef.	s.e.	coef.	s.e.	coef.	s.e.	Obs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
TFP	0.050***	(0.016)	0.018	(0.021)	0.068**	(0.026)	36,630
Labour productivity	0.033**	(0.017)	0.010	(0.015)	0.043**	(0.029)	37,140
Firm Fixed effects	Yes		Yes		Yes		
Year Fixed effects	Yes		Yes		Yes		

7 Do PE-backed firms outperform matched industry peers during economic downturns?

7.1 Background

In the final section of the paper we turn our attention to two recent periods of major economic shocks: the global financial crisis (hereafter GFC), and the COVID-19 pandemic. While each shock was very different in nature and the economic consequences, both periods were

characterised by a decline in firm performance, and an increased risk of financial distress (see for example Duchin et al. (2010), Kahle and Stulz (2013), Bernstein et al. (2019), Campello et al. (2020), Papanikolaou and Schmidt (2022), Tawiah and O'Connor Keefe (2023)). On a similar note, it has been well-documented that productivity in the UK declined during each of these crisis periods (see for example Bloom et al. (2019) and Douch et al. (2022)). The failure of the UK to recover its productivity performance to its pre-GFC levels, and the consequent lag behind peer OECD countries such as the US, France and Germany, has been dubbed "the productivity puzzle" and has been widely discussed across academic, policy, and financial press circles (see for example, Barnett et al. (2014), Riley et al. (2014), Fernald (2015), Riley et al. (2015), Tetlow (2017), Wolf (2020), Strauss (2021), Economist (2022)).

The role of PE investors during periods of economic crises is often debated. A key concern is that, due to excessive amounts of leverage which may be involved in buyouts, PE investors may exacerbate the effects of financial crises by increasing firms' distress risk (ITUC (2007), Rasmussen (2008)). However, a more optimistic view holds that investors may be able to help their portfolio companies stave off the effects of economic crises and periods of uncertainty through improved access to credit, injecting further equity investment, and by leveraging their wide industry networks (Bernstein et al. (2019)). The existing empirical evidence on PE-backed companies' performance during the GFC provides some support for the latter view. PE-backed firms in the UK appear to have been more resilient to the crisis relative to their non-sponsored peers (Wilson et al. (2012), Bernstein et al. (2019)). However, Bernstein et al. (2019) focus on firm investment, debt and equity inflows, and market share, and not productivity. Similarly, while Wilson et al. (2012) study productivity differentials across firms, we offer a more robust empirical analysis based on a DiD approach. This section draws on (Lavery and Wilson (2022a)) who study the performance of PE-backed companies during the recent COVID-19 pandemic period.

As before, we build samples of PE-backed firms which were under PE ownership during each crisis period, and matched control firms which are similar based on their observable

characteristics. In this section we construct two distinct samples of treated and control firms: one for studying firm productivity during the GFC, and another for studying firm productivity during the COVID-19 pandemic. The selection strategy of buyouts follows that of Bernstein et al. (2019), who study firm behaviour during the GFC. As such, we take all PE deals involving a UK-based target firm which take place before the end of the pre-GFC and COVID crisis years, 2007 and 2019, respectively, and where the private equity investor has not exited before the end of 2008 and 2020.

Our matching technique is similar as before, but this time it involves matching private equity-backed firms to control firms based on the two groups of firms having similar characteristics in the *pre-crisis* years (2007 and 2019). Accordingly, we match control firms to private equity-backed firms based on the industry in which they operate, and on their size, profitability and leverage in 2007, 2019 - the years before the onset of the crises. As such, we select up to 5 companies for each portfolio company which: 1) operate in the same 2-digit SIC code; 2) have total assets within 50% of the target firm in 2007; 3) have a return on assets within a 50% bracket of the target company, and 4) have leverage (total debt/assets) within 50% of the target in 2007 and 2019. Using this method, we construct two samples of PE-backed and control firms around each crisis: 417 PE-backed firms and 1,840 control firms for the GFC; and 1,022 PE-backed and 4,054 control firms for the COVID pandemic. Descriptive statistics of the matched samples are provided in Tables 3 and 4 in the appendix.

Figure 7 displays the evolution of PE-backed and matched control firms around the GFC, and around the COVID-19 pandemic by plotting the α_t from the following equation:

$$TFP_{it} = \alpha_t + \alpha_i + \varepsilon_{it} \tag{7.1}$$

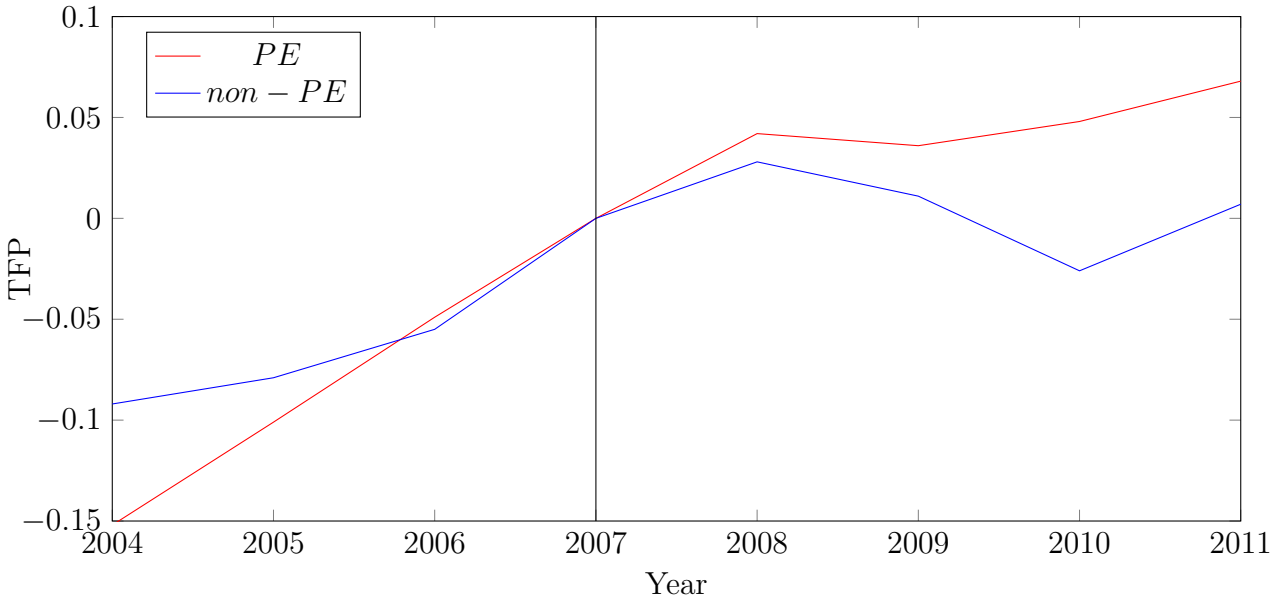
where TFP_{it} is total factor productivity for firm i at time t. α_t captures year fixed effects and α_i denotes firm fixed effects. We use the year before each crisis period as the base period (2007 for the GFC and 2019 for the COVID-19 pandemic), and we normalize its corresponding coefficient to zero. We estimate the equation separately for both the PE-

backed and matched control samples, with standard errors clustered at the firm level. In both instances, the pre-crisis trends in the graphs show relatively similar patterns. In each pre-shock period, the treated and control firms follow a similar trend, validating the matching algorithm used, and indicating satisfaction of the parallel trends assumption required for a DiD analysis. At the onset of the GFC and the COVID-19 pandemic, while the productivity of PE-backed firms does fall, it falls by considerably less than that of matched sample, suggesting a cushioning effect of PE ownership during crises periods.

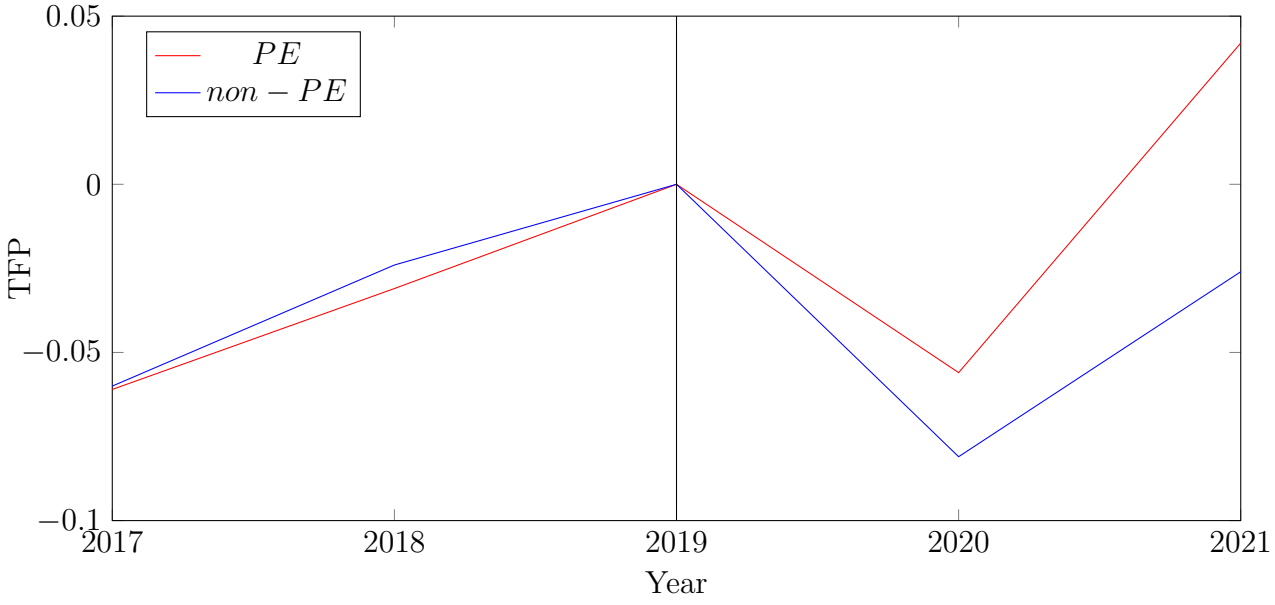
Figure 7: The effect of PE ownership on productivity during crisis periods

This figure illustrates the trends in firm-level productivity for treated and control firms around the GFC and the COVID-19 pandemic. Specifically, the graphs shows the α_t of the following equation: $y_{it} = \alpha_t + \alpha_i + \varepsilon_{it}$. α_t captures year fixed effects, and α_i captures firm fixed effects. y_{it} is total factor productivity. The year prior to each crisis is the reference period (2007 and 2019 respectively) and its corresponding coefficient is normalized to zero. Standard errors are clustered at the firm-level. Panel A shows the GFC, and panel B shows the COVID-19 pandemic.

Global financial crisis



COVID-19 pandemic



We proceed to estimate our DiD empirical model:

$$y_{it} = \alpha_t + \alpha_i + \beta_1(PE_i * Post_t) + \theta X_i * Post_t + \varepsilon_{it} \tag{7.2}$$

PE_i is a dummy variable that equals one for PE-backed companies, and zero for the control group. $Post_t$ is a dummy variable that equals one for observations during the GFC (COVID-19 pandemic) period of 2008 to 2011 (2020 to 2021), and 0 in the pre-GFC/pandemic years. The model also includes firm-level controls, as before. These are taken in the pre-crisis year and are interacted with the $Post_t$ variable. Similarly, we include year fixed effects, α_t, and firm fixed effects, α_i. Standard errors are clustered at the firm-level. The main coefficient of interest is β_1, which will capture the estimated change in private equity targets' productivity from before the GFC/pandemic to after the GFC/pandemic outbreak, relative to the control group.

7.2 Results

The estimates from 7.2 are presented in Table 10. Columns 1 to 4 report estimates for total factor productivity and labour productivity during the global financial crisis, and columns 5 to 8 report estimates during the COVID-19 pandemic. Even-numbered columns include a vector of firm-level controls, while all specifications include firm and year fixed effects.

The estimated coefficients in columns 1 and 2 of Table 10 suggest that PE-backed firms experienced a TFP increase by over 5% compared to matched control firms in the GFC period, implying that TFP of PE-backed companies fell by less than that of the matched control firms during the GFC. This effect is not only statistically significant, but also large in economic magnitude. Adding firm controls has a minimal effect on the results. The estimated coefficients in columns 3 and 4, suggest that PE-backed firms' labour productivity increased by approximately 2% during the financial crisis relative to the matched group. These findings are consistent with previous studies of PE-backed firms performance during

the financial crisis (Wilson et al. (2012), Bernstein et al. (2019)). Columns 5 to 8 reports estimates from the recent COVID-19 pandemic. The estimated coefficients are comparable in both statistical significance and in magnitude with those reported in columns 1 to 4. Specifically, the estimates suggest that PE-backed companies experience an increase in TFP (labour productivity) by around 3% (4%) relative to matched, non-PE-backed firms during the COVID-19 pandemic. Combining with Figure 7.2, these findings support the view that although PE backed firms productivity declined in each of the two distinct episodes, it fell by less in comparison to the control group, suggesting that PE ownership can enhance firm resilience during economic downturns.

Table 10: Productivity during the GFC and COVID-19 Pandemic

The below estimates are from a DiD estimation. PE is a dummy variable taking the value one for PE-backed firms, and zero for control firms. Standard errors are reported under the coefficients in parenthesis and *, **, *** indicate levels that are significantly different from zero at the 10%, 5% and 1%, respectively.

	GFC				COVID-19			
	TFP		Labour prod		TFP		Labour prod	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PE*Post	0.055***	0.053***	0.021**	0.020**	0.035**	0.031**	0.041**	0.038**
	(0.016)	(0.017)	(0.010)	(0.010)	(0.012)	(0.014)	(0.023)	(0.024)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	8,455	8,455	12,803	12,803	15,599	15,599	19,384	19,384

8 Conclusion and future research

Overall, the findings of this study suggest that private equity funds can boost firm-level productivity in their portfolio companies in the UK. This largely complements earlier work studying the link between PE ownership and productivity (Lichtenberg and Siegel (1990), Amess (2003), Harris et al. (2005), Wilson et al. (2012), Davis et al. (2014)). Using the most recent and up-to-date deal-level UK data, the conclusions of the analysis are threefold: Firstly, PE buyouts appear to have a positive impact on target firm total factor productivity and labour productivity. Second, this positive impact of PE ownership on productivity appears to persist even after the investor has exited the firm. Lastly, the results suggest that PE-backed firms' productivity is more resilient during economic downturns.

The findings are particularly pertinent as UK productivity growth has stalled considerably over the last decade and lags behind that of other developed economies (Riley et al. (2015), Fernald (2015), Wolf (2020), Economist (2022)). A lack of business investment and difficulties in accessing finance have been cited as potential drivers of the UK's stagnating productivity (Riley et al. (2015), Tetlow (2017)). Consequently, promoting private capital investment, such as venture capital and private equity investment, could help not just in widening firm-level access to finance, but in boosting firm growth and productivity.

It is important to note, however, that private equity ownership does not come without considerable risks for target firms. PE investors are often criticised for their short termism (Stiles (2021)) and for leaving companies vulnerable to distress after loading them with debt to juice their own potential returns and paying themselves handsome dividends during their ownership stint (Appelbaum and Batt (2014)). There exist plenty of examples both in the UK and abroad of companies which have, under PE ownership or shortly after being PE-owned, entered into formal bankruptcy procedures or filed for insolvency. Recent notable examples include Debenhams and Toys R Us. Moreover, PE sponsors can often charge many different types of fees to their portfolio companies (for an overview, see Phalippou et al. (2018)). Somewhat typical of the PE industry, there is a lack of transparency into

what fees are charged, and how much is charged, to companies. These fees can be disguised as dividends, as PE investors can take cash out of the company and label it a fee instead of a dividend, as fees, unlike dividends, are tax deductible (Polsky (2014a), Polsky (2014b)).

Future research could delve deeper into the mechanisms through which PE investors may be able to add value to portfolio companies through improvements in productivity. Specifically, broad PE portfolio company growth strategies can be split into organic growth deals, and acquisitive growth deals, commonly known as "buy-and-build deals". This strategy involves a PE investor acquiring a platform company to which it then adds on several bolt-on acquisitions to create a larger organisation with an increased market share and can lead to consolidation within the market. This has become an increasingly popular strategy among PE investors (Hammer et al. (2017) Bansraj (2019), Bansraj et al. (2022), Hammer et al. (2022)). It could be an interesting avenue to disentangle organic deals from buy-and-build deals and examine portfolio company productivity changes within each sub-strategy. Another relevant question could be the role played by the management team and board of directors of the portfolio company. It is well-observed that a key change in portfolio firms often brought about by PE investors is the recruitment of senior management personnel as well as appointing directors to the board and appointing new board chairs and CEOs (Lerner et al. (2012), Gompers et al. (2016), Gompers et al. (2023)). Wilson et al. (2022b) show that director-level attributes matter for portfolio firms' exporting performance. Director- or management-level data could allow for a rich analysis of human capital factors which may encourage or restrict productivity improvements in target firms.

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