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ORIGINAL ARTICLE

Sector-based portfolio changes of private equity funds during economic shocks

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Abstract
Private equity investments are highly sensitive to economic shocks due to their assets' high leverage and illiquidity. Allocations to PE have significantly increased over the past decade; research on portfolio selections during economic shocks however remains scarce. We bridge this gap by analyzing sector-level re-allocations during three global economic shocks (the DotCom-bust, the Global Financial Crisis, and COVID-19). We do so by comparing the share of sectoral capital six months before each shock with capital allocations made during the shocks, using a dataset of more than 53,000 buy-side transactions. Specific sectors showed increased transactions from PE investors across all shocks, indicating positive perception from investors in times of uncertainty. Our findings entail: Limited Partners need to critically assess industry-orientated investments of General Partners and challenge over-allocation in perceived "safe harbor" industries, especially when General Partners have no specialization in these industries. When the General Partners are industry-specialized, however, Limited Partners can unlock significant return potential when they agree to an extended investment period. For General Partners with expertise in sagging industries, shocks offer investment opportunities as competition shies away and valuations decrease. Companies in sagging industries seeking external capital should target sources other than PE or accept increased return expectations.

Keywords Portfolio management · Portfolio selection · Private equity funds

JEL Classification G01 · G11 · G23

Introduction

Private equity (PE) returns are highly sensitive to liquidity shocks (Franzoni et al. 2012). Economic shocks pose challenges to the asset class, as shocks limit access to new committed capital (Rizzi 2009) and impede access to debt (Seretakis 2012). Acquisitions, therefore, require higher equity proportions, limiting returns and putting pressure on valuations (Uddin and Chowdhury 2021). While reduced valuations can unlock takeover opportunities, they pose challenges for investors seeking to exit from existing investments. Despite the impact of shocks on PE investing, research is scarce as most studies focus on pre-crisis periods (Sahli and Khemiri 2020). Studies mainly focus on one event (e.g., the Global Financial Crisis, GFC), often in only one region; therefore, we cannot assume that their findings are widely applicable as the dynamics of each shock are individual. We look at how PE firms invest during times of crisis and address this gap by finding commonalities across shocks and regions, helping General Partners (GPs) improve investment strategies in times of uncertainty. Applying an industry-level focus is an essential element of our analysis, as GPs with industry specializations increase returns (Gilligan and Wright 2020).

We show that certain industries exhibit coherent dynamics concerning capital allocation across shocks. The energy, banking, insurance, and life science sectors consistently increased investment shares. Conversely, the materials and technology hardware sectors consistently decreased shares.

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This indicates several implications for GPs and Limited Partners (LP).

For GPs with expertise in sagging industries, shocks offer significant opportunities. Short-term exit options, and therefore capital distribution capabilities, diminish, yet the pool of takeover candidates increases as competitors shy away. This puts pressure on the short term and opens strong profit potential in the long term. Capitalizing on these opportunities requires GPs to re-configure their portfolio allocation, fund timeline, risk preference, and alignment with the overall investment strategy.

Also, LP must re-align their investment horizon and risk preferences. Short-term capital distributions from mature funds invested in sagging industries affect profits, while additional flexibility provides mid-term returns, especially for industry-specialized funds.

Conversely, companies in the materials and technology hardware sectors should target sources other than PE when seeking external capital during a shock.

The remainder of this study is structured as follows: "Related literature" section reviews the related literature. "Data and methodology" section" describes our methodology. "Results and discussion" section presents and discusses our results, and conclusions are offered in "Conclusion" section.

Related literature

Fund performance and the ability to raise follow-on funds are strongly correlated with boom-and-bust cycles (Kaplan and Schoar 2005). Burth and Reißig-Thust (2019) show that GPs must differentiate strategies to build profiles and improve financing terms. Specialization verticals include industries, transaction types [growth equity, venture capital (VC)], or transaction sizes. Cash flows and financial performances differ across industries (Gombola and Ketz 1983), indicating varying suitability for PE takeovers.

Aside from an industry's economic dynamics and a fund's ability to capture them, industry specialization is a source of competitive advantage. Cressy et al. (2007) find that PE funds with industry specialization generate 8.5% return premia. Le Nadant et al. (2018) added that a driver of superior performance is a GP's ability to identify suitable takeover candidates, i.e., companies in targeted industries that were performing poorly but offer potential for operational improvements.

These findings indicate two prerequisites for sectoral adjustments during shocks: First, GP with industry expertise should only shift away from their "home" industries when changes in sector dynamics are expected to have an impact on returns that exceeds the fund's ability to generate profitability premiums (i.e., an impact greater than 8%). Second, when shifting a sectoral focus to industries outside their areas of specialization, GPs are at a knowledge disadvantage compared to those who specialize in industry and are therefore disadvantaged in bidding processes.

Speed is a key determinant of success in sectoral reallocation. Funds that react quickly to changing conditions have an advantage and can expect to raise funds and return capital to shareholders faster (Ljungqvist et al. 2020). This timing component exposes investors to two challenges: An intended exit may coincide with a period of downcycling, including lower valuations, and the initial buy-in may occur at a high point in the cycle.

Thus far, PE research focused on an aggregate level, emphasizing macroeconomic indicators rather than GPs' approaches to adjusting their investment practices (Cabral-Cardoso et al. 2016). However, research does show that GPs modify their strategies during shocks. In the VC arena for example, managers prefer later-stage targets over early-stage targets in such periods (Paik and Woo 2014).

Bellavitis et al. (2022) analyze aspects of VC funds' industry-related investment strategies and find that investments in the travel industry declined during COVID-19 while investments in the biotech industry increased. We systematically extend their findings to a broader range of strategies (LBO, growth equity, VC), industries, and shocks.

Haarmeyer (2020) concludes that GPs avoided cyclical sectors during COVID-19. Malik et al. (2020) show that during COVID-19, GPs in India shifted capital toward sectors such as education, healthcare, and financial services. Sahli and Khemiri (2020) found that bidding for industrial companies declined among GPs in France during the GFC. Musatova (2009) concludes that Russian PEs shifted toward less cyclical industries during the GFC. For VC investors in the USA, Townsend (2015) finds that being overexposed to IT-related sectors during the DotCom-bust resulted in capital setbacks and limited access to financing. Croce et al. (2019) track investment volumes throughout the GFC and differentiate between capital-intensive and labor-intensive industries. Gompers et al. (2022) surveyed GPs and included a rating of attractiveness among various industries during COVID-19. GPs viewed energy, utilities, and industrials as unattractive sectors compared to IT, healthcare, and telecommunications. Arundale and Mason (2020) observe that during COVID-19, GPs shifted capital away from hard-hit sectors (travel and hospitality) to companies in digital healthcare, cybersecurity, and AI. These findings are consistent with those of Chen et al. (2021), who identified healthcare and online services as the most investable industries during COVID-19.

Research on industry relevance during shocks is not limited to PE/LBO funds; it extends to also hedge funds and VC (see Tashanova et al. 2020). Bellavitis et al. (2022) show the likelihood of early-stage ventures obtaining financing during COVID-19 differed dramatically when comparing travel to

biotech ventures. De Vries and Block (2011) assess the likelihood of syndication before and during the GFC and DotCom crises for VCs. Cumming et al. (2009) compare early-stage, expansion-stage, and later-stage investments across internet, biotech, and other industries under scarce liquidity. According to Mason (2020), angel and VC investors favored "startups with a pandemic purpose" during COVID-19.

Although several studies address the sectoral focus among PE funds during shocks, this research has substantial limitations. First, most of these studies consider a single shock (e.g., COVID-19). Second, they typically analyze only one region (e.g., the USA). Third, only one type of investor (e.g., VC) is assessed. This means the results are hardly generalizable. Economic dynamics of shocks differ by event (e.g., due to supply/demand dynamics and their implications).

We address these limitations: First, we include three shocks in our analysis (DotCom-bust, GFC, and COVID-19). Second, we use a global dataset that covers several regions and different types of investors (LBO, growth equity, and VC).

In this study, we investigate whether GPs disproportionally invest in specific industries during shocks. The severity of downturns and recovery speed during shocks differ by industry (Jiang et al. 2021). Investors therefore re-allocate capital, to less-affected industries. Uddin and Chowdhury (2021) show that higher equity proportions pressure valuations, emphasizing the importance of related deal volumes and transaction sizes. We therefore propose Hypothesis 1:

1. Shocks negatively affect deal parameters such as valuation, transaction size, and transaction volume.

Sahli and Khemiri (2020) observed declines in investments in the industrial sector during the GFC, while Gompers et al. (2022), and Chen et al. (2021) found preferences for IT and healthcare investments during COVID-19. Thus, we propose Hypothesis 2:

2. During shocks, investors allocate more investments to specific industries, such as energy or financial services.

Malik et al. (2020) explain that PE capital shifted to industry groups with robust business models during COVID-19, while Haarmeyer (2020) concludes that investors avoided cyclic sectors. We, therefore, form Hypothesis 3:

3. During a shock, investors prefer non-cyclical over cyclical industries.

Data and methodology

The format of an event study was not chosen, as it is not fully applicable for various reasons: First, we strive to develop general implications. One event would limit the generality of results. Second, dynamics differ between shocks. The GFC, for example, strongly affected the financial sector, while healthcare was not. This contrasts with COVID-19, which impacted the healthcare industry but not the financial sector. We, therefore, have an asymmetrical effect on the industries affected. Third, data availability has increased significantly over time as PE transactions have increased. Focusing purely on the DotCom-Shock in an event study would limit the number of available transactions.

The data used are based on PE transactions and were retrieved from Mergermarket, a financial database with extensive data on PE-related transactions (Tian 2024). The period studied is from January 1998 to October 2022. We chose a long-range timeframe because it allows to include three major shocks, i.e., the DotCom-bust in 2000 (Ljungqvist and Wilhelm 2003), the GFC of 2008–2009 (Blankenburg and Palma 2009), and COVID-19 from 2020 (Harjoto and Rossi 2023). Only PE buy-side transactions are included. Transactions are determined by their announcement date, which is closest to the investment decision and is thus best suited to represent investment decisions at a given time.

We made the following adjustments to the dataset before conducting our analysis:

1. *Imposed consistent industry classification:* The dataset contains information about the target's industry; however, the values follow no coherent system. We modified industry classifications using the GICS standards and aligned the data on industry-branch levels (see Stanley 2001).
2. *Added Purchasing Manager Index (PMI) values.* To capture shocks quantitatively, we added the PMI index. We assume that a PMI below 45 indicates a shock, as generally, a PMI below 47 indicates the manufacturing sector is contracting (Koenig 2002). This approach allows us to compare over time, avoiding heteroscedasticity risks. This index-based approach allowed us to trace crisis length with defined start and end points. Since the starting point can be defined based on the PMI index, we built the average across the preceding six months, reflecting previous investor preferences in industries. Although the PMI is manufacturing-focused, it is considered a leading indicator for overall economic growth.
3. *Classified cyclical and defensive industries.* The industry categories were sorted into cyclical and defensive using

Damodaran's (2021) data on betas (βs) per industry. We use average, unleveraged βs for 2018–2021, corrected for cash, to account for industry-wide patterns in cash holdings. We compute the simple average β across all industries and define cyclical industries as having above-average unleveraged βs and defensive industries as those having below-average βs.

In our research, the Asian and Russian crises in 1997 and 1998, respectively, are not included.

The Asian crisis, driven by financial liberalization (Climent and Meneu 2003), hit five national stock markets from July 1997 onward. The Russian crisis began in August 1998 with the default of ruble-denominated debt obligations (Merrick 2001). Despite varying dynamics, both events resulted primarily in a regional currency crisis (Gunay and Can 2022).

Our shock definition is based on a PMI index value below 45, while 47 is assumed to indicate a contracting manufacturing sector (Koenig 2002). For the Russian and Asian crises, the PMI ranged between 46.8 (December 1998) and 57.7 (July 1997), above the threshold PMI criteria. Despite the impact on regional economies, the relevance for the global economy was somewhat limited.

Additionally, PE in both regions was at an early stage of development at that time. In our set for Russia in 1998, only the stake acquisition of KKR in Imperial Porcelain was included. Thus, additional observation points would have had a negligible effect.

The three shocks included in our analysis differ in their properties. At first, the origin of the shock differed. COVID-19 was an exogenous shock, not of an economic but viral nature (Borio 2020). This contrasts with the economic nature of the GFC, which originated in the financial sector, and the DotCom-bust, which originated in the technology and financial sectors (Alexakis et al. 2021).

Second, the geographical scope differed. The GFC and DotCom-bust mostly affected western financial markets, while COVID-19 had a global scope (Borio 2020).

Third, the impact differed; the GFC and DotCom-bust had human and intentional drivers, indicating a high ability to control them. Conversely, the non-human steered viral outbreak during COVID-19 lacked control, and therefore, uncertainty was significantly higher (Agaton et al. 2024).

Fourth, the speed differed. COVID-19 showed a faster downturn and recovery compared to DotCom-bust and GFC. From the pre-pandemic stock market high to local minimum took four weeks, during the GFC it took 23 weeks, and during the DotCom-bust, it took 109 weeks. The economic recovery during COVID-19 was sharp, while it took significantly longer during the GFC and DotCom-bust (Davis and Zlate 2023).

The dataset contains 53,472 transactions. Transactions increased over time, in line with increasing PE investments. The regional distribution is concentrated in North America and Europe, as shown in Fig. 1.

The dataset includes transactions from various industries, with concentration in commercial services, personal products, and life science as shown in Fig. 2.

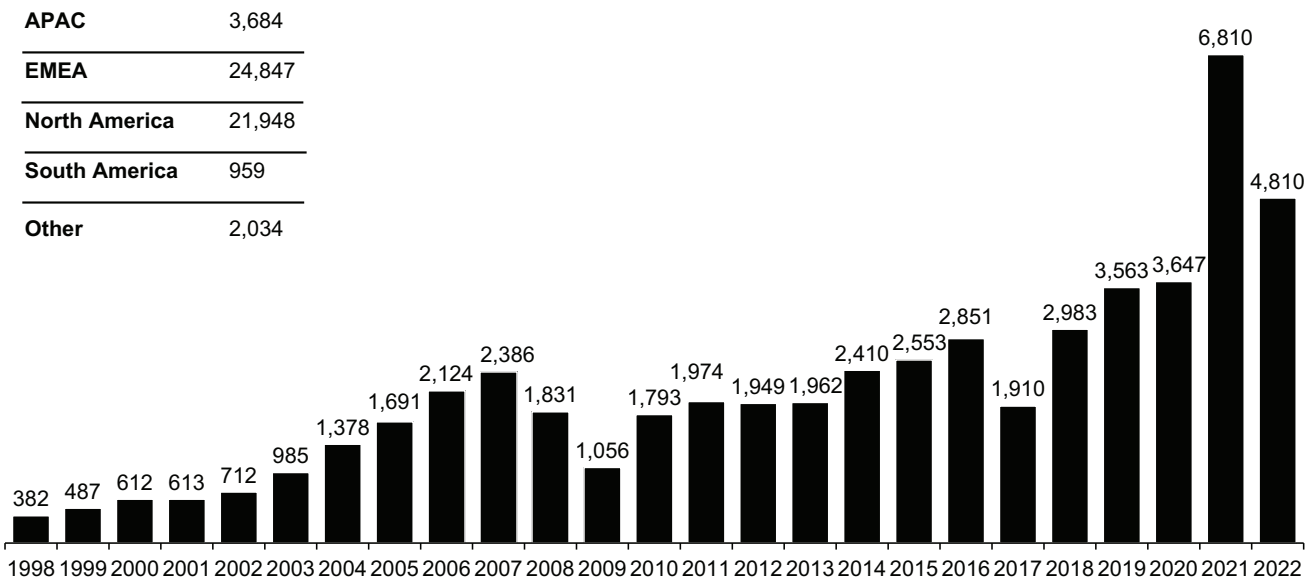

Fig. 1 Data points per year. This figure presents the number of PE transactions included in the dataset per year

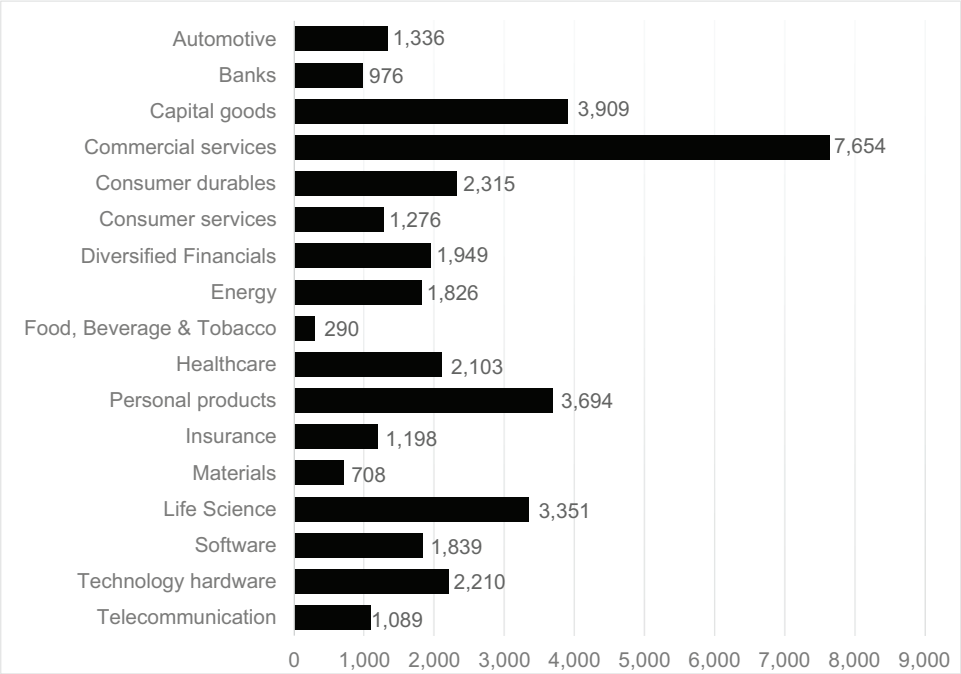

Fig. 2 Data points per industry. This figure presents the number of PE transactions included in the dataset per industry (delta to 53,472 is "other" industries)

Table 1 Comparison of key transaction parameter during shock and no-shock periods

	N	Mean	SD	Std. error mean	95% confidence interval	
					Lower bound	Upper bound
EBITDA-multiple						
No-shock	3600	11.56	5.68	0.094	11.37	11.75
Shock	126	10.28	6.00	0.535	9.22	11.34
Deal value						
No-shock	22,480	311.3	1086.97	7.249	297.09	325.51
Shock	924	216.5	726.58	23.90	169.6	263.42

This table presents the comparison between shock and no-shock periods in key transaction parameters EBITDA-multiple and deal value

Results and discussion

We compute Pearson correlation coefficients using the PMI to assess the impact of the economic environment on drivers of PE transactions. The Pearson correlation between the PMI and unleveraged β is 0.051 (significant at 0.003). This indicates a weak but significant relationship, although the value is below the threshold of 0.1 to be considered meaningful. We find similar results for PMI and EBITDA-multiple, with a correlation of 0.05 (significant at 0.003), again below the threshold. The correlation between PMI and deal value is 0.015 (significant at 0.022), again below the threshold. Overall, the correlation analysis shows weak but significant correlations between the PMI and valuation metrics that are too low to be considered meaningful.

EBITDA-multiple during non-shocks averages 11.6×, falling to 10.3× during shocks (Table 1). The independent

Table 2 Descriptives of EBITDA-multiples and comparison between shocks and no-shocks periods

	B	EBITDA-multiple			
		Std. error	Beta	*t*	Significance
No-shock	11.565	0.095	–	121.848	–
Shock	−1.286	0.516	−0.041	2.491	0.013

This table presents the comparison of EBITDA-multiples between shock and non-shock periods

t-test shows $t = 2.491$ (0.013 significance level; $t = 2.5$; $df = 3{,}724$), indicating significant values. The mean deal value is EUR 311m during non-shocks, which is higher than the mean of EUR 216m during shocks. The unstandardized coefficient for shocks is −1.286 (std. error of 0.516, Table 2), implying an estimated regression equation of:

$$\text{EBITDA During Shock} = 11.6 - 1.3x = 10.3$$

where x is a binomial dummy variable and equals "1" in case of shock.

The negative coefficient indicates that EBITDA-multiples (i.e., deal valuations) decline during shocks.

Similar results are found for deal value. The mean value during non-shock periods is EUR 311m, with SD of 1086 (Table 1). During shocks, the average value decreases to EUR 216m with a SD of 726. The SD is skewed with increased scattering, so we cannot apply additional parametric tests. Results align with Uddin and Chowdhury's (2021) observations of pressure on valuations and confirm takeover opportunities, as discussed in Neely and Carmichael (2021).

These findings are consistent with Hypothesis 1, as key parameters decrease.

Next, we assess whether GPs shift their focus toward specific industries. We apply the chi-square test and obtain a value of 144.57 (significant at the 0.001 level), indicating that GPs prefer to invest in specific industries during shocks.

Next, we review at the industry level. We compare the share of transactions in each industry per shock to the share six months prior. We prevent time-related comparison bias from overweighted averages. The results reveal mixed dynamics for most industries; however, specific industries show consistent responses, namely banking, energy, insurance, materials, technology hardware, and life science. Both materials and technology hardware consistently show a reduced share, while shares of banking, energy, insurance, and life science increased (Table 3).

We performed the same analysis, reducing the average to three months prior. Results remained constant, with differences found only in the energy sector (shares increased during the GFC and COVID-19 but decreased during the DotCom-bust), media (constant decrease), and telecommunication (constant increase). All other outcomes remained equal (Table 4). A chi-square test confirmed significance at the 0.0056 level.

We contrasted the results by analyzing the peak phases of shocks, running the analysis with a PMI threshold of 43 (Table 5). Dynamics remained unchanged for banks, energy, insurance, materials, and technology hardware. The magnitude of shifts increased, however, for several industries. Material investments shifted at a higher pace (−5.5 ppt, −2.0 ppt, and 2.7 ppt during DotCom, GFC, and COVID-19, respectively) compared with the PMI 45 threshold (−4.4 ppt, −1.8 ppt, and −1.7 ppt during DotCom, GFC, and COVID-19, respectively). Similar results were obtained for commercial services (+2.0 ppt, +0.1 ppt, +5.2 ppt during DotCom, GFC, and COVID-19, respectively) compared with the PMI

Table 3 MSCI industries shares throughout major shocks

	DotCom		GFC		COVID-19		Percentage-point change		
	Before (%)	Shock (%)	Before (%)	Shock (%)	Before (%)	Shock (%)	DotCom (%)	GFC (%)	COVID-19 (%)
Automotive	4.6	3.3	3.3	3.4	2.2	2.6	−1.4	0.1	0.4
Banks	3.5	4.0	2.7	3.0	1.2	1.6	0.5	0.3	0.4
Capital goods	6.5	10.5	10.0	8.6	8.1	5.0	4.0	−1.4	−3.1
Commercial services	12.5	13.0	15.0	13.8	16.7	18.7	0.5	−1.1	2.0
Consumer durables	5.7	6.9	6.9	7.2	3.5	0.8	1.2	0.3	−2.7
Consumer services	2.2	3.4	2.8	1.9	2.2	0.8	1.3	−0.9	−1.4
Energy	0.5	0.6	3.7	4.4	3.0	3.4	0.0	0.7	0.4
Food, beverage and tobacco	4.6	3.8	4.4	5.7	3.2	3.4	−0.8	1.3	0.2
Healthcare	4.1	4.6	5.4	4.2	8.2	11.3	0.5	−1.2	3.1
Personal products	2.7	3.6	2.7	3.3	2.2	2.1	0.9	0.6	−0.1
Insurance	0.8	1.5	1.3	1.5	1.4	2.9	0.7	0.2	1.5
Materials	9.2	5.9	8.5	7.7	5.0	2.9	−3.3	−0.8	−2.1
Media	3.3	4.0	4.0	3.6	3.5	2.6	0.8	−0.4	−0.8
Life sciences	1.6	1.7	1.5	2.0	2.5	3.7	0.1	0.5	1.2
Software	9.5	6.3	6.4	8.6	20.3	23.7	−3.2	2.1	3.4
Technology hardware	7.6	5.9	4.8	4.0	3.8	2.6	−1.7	−0.8	−1.2
Telecommunication	3.3	3.3	1.7	1.5	1.2	2.1	0.0	−0.2	0.9
Cyclical	59	57	60	61	67	66	−1.8	1.0	−0.3
Defensive	41	43	40	39	33	34	1.8	−1.0	0.3

This table presents the share of transactions per MSCI-Industry across three shocks. The "Before"-Period measures the share 6 month prior to each shock, based on transactions volumes (*not value*). Cumulative delta to 100% consists of "other" industries

Table 4 MSCI industries shares throughout major shocks

	DotCom		GFC		COVID-19		Percentage-point change		
	Before (%)	Shock (%)	Before (%)	Shock (%)	Before (%)	Shock (%)	DotCom (%)	GFC (%)	COVID-19 (%)
Automotive	3.7	3.3	3.1	3.4	2.0	2.6	−0.4	0.3	0.7
Banks	1.5	4.0	2.6	3.0	1.3	1.6	2.6	0.5	0.3
Capital goods	3.7	10.5	12.8	8.6	7.9	5.0	6.9	−4.2	−2.9
Commercial services	12.5	13.0	14.6	13.8	15.7	18.7	0.5	−0.8	3.0
Consumer durables	6.6	6.9	5.5	7.2	2.4	0.8	0.3	1.7	−1.6
Consumer services	2.2	3.4	2.0	1.9	1.5	0.8	1.2	−0.1	−0.7
Energy	0.7	0.6	3.8	4.4	3.0	3.4	−0.2	0.6	0.4
Food, beverage and tobacco	5.1	3.8	3.5	5.7	2.5	3.4	−1.3	2.2	0.9
Healthcare	5.1	4.6	5.7	4.2	9.1	11.3	−0.5	−1.5	2.2
Personal products	4.4	3.6	2.0	3.3	2.0	2.1	−0.8	1.3	0.1
Insurance	0.7	1.5	0.5	1.5	1.5	2.9	0.8	1.0	1.4
Materials	10.3	5.9	9.5	7.7	4.6	2.9	−4.4	−1.8	−1.7
media	4.4	4.0	5.1	3.6	3.6	2.6	−0.4	−1.5	−0.9
Life sciences	2.2	1.7	1.5	2.0	2.8	3.7	−0.5	0.6	0.9
Software	10.3	6.3	4.6	8.6	22.9	23.7	−4.0	4.0	0.8
Technology hardware	9.6	5.9	5.9	4.0	3.5	2.6	−3.6	−1.8	−0.8
Telecommunication	2.9	3.3	1.3	1.5	1.4	2.1	0.3	0.2	0.7

This table presents the share of transactions per MSCI-Industry across three shocks. The "Before"-Period measures the share 3 month prior to each shock, based on transactions volumes (*not value*). Cumulative delta to 100% consists of "other" industries

Table 5 Peak of MSCI industries shares throughout major shocks

	DotCom		GFC		COVID-19		Percentage-point change		
	Before (%)	Shock (%)	Before (%)	Shock (%)	Before (%)	Shock (%)	DotCom (%)	GFC (%)	COVID-19 (%)
Automotive	3.7	5.3	3.1	3.2	2.0	3.2	1.6	0.1	1.2
Banks	1.5	3.9	2.6	3.0	1.3	1.3	2.5	0.5	0.0
Capital goods	3.7	7.9	12.8	7.3	7.9	3.8	4.2	−5.5	−4.1
Commercial services	12.5	14.5	14.6	14.6	15.7	20.9	2.0	0.1	5.2
Consumer durables	6.6	4.8	5.5	7.3	2.4	0.0	−1.8	1.8	−2.4
Consumer services	2.2	2.6	2.0	1.7	1.5	0.6	0.4	−0.3	−0.9
Energy	0.7	1.3	3.8	4.7	3.0	4.4	0.6	0.9	1.4
Food, beverage and tobacco	5.1	3.9	3.5	6.1	2.5	2.5	−1.2	2.6	0.0
Healthcare	5.1	3.5	5.7	4.4	9.1	10.8	−1.6	−1.3	1.7
Personal products	4.4	4.8	2.0	3.5	2.0	1.9	0.4	1.5	−0.1
Insurance	0.7	1.3	0.5	1.7	1.5	1.9	0.6	1.1	0.4
Materials	10.3	4.8	9.5	7.5	4.6	1.9	−5.5	−2.0	−2.7
Media	4.4	4.4	5.1	3.8	3.6	2.5	0.0	−1.3	−1.0
Life science	2.2	1.3	1.5	2.1	2.8	3.8	−0.9	0.7	1.0
Software	10.3	9.2	4.6	8.2	22.9	27.2	−1.1	3.6	4.3
Technology hardware	9.6	6.6	5.9	4.0	3.5	3.2	−3.0	−1.9	−0.3
Telecommunication	2.9	3.5	1.3	1.5	1.4	1.9	0.6	0.2	0.5

This table presents the share of transactions per MSCI-Industry during the peak of each shock, based on a PMI threshold of 43. The "Before"-Period measures the share 3 month prior to each shock, based on transactions volumes (*not value*). Cumulative delta to 100% consists of "other" industries

45 threshold (+0.5 ppt, −0.8 ppt, and +3.0 ppt during Dot-Com, GFC, and COVID-19, respectively). The magnitude of re-allocations increases with uncertainty, chi-square test indicated significance at 0.00369.

The results confirm Hypothesis 2. GPs shift investments toward or away from specific industries during shocks.

We extend the analysis, assessing whether GPs prefer defensive industries during shocks. Pearson's chi-square value of 63.471 (significant at the 0.000 level) shows that GPs prefer cyclic industry investments even during shock times. However, capital allocation in defensive industries increases. Valuation levels do not drive this, as the average EBITDA-multiple for cyclical industries during shocks is 10.2× compared to 10.3× for defensive industries.

Hypothesis 3 is therefore accepted, as there is a shift in cyclic versus defensive industries during a shock.

We construct an ANOVA for EBITDA-multiple and deal value and conclude no significant difference across regions exists.

Our analysis does not support Haarmeyer's (2020) hypothesis of a unified shift toward defensive industries. The same applies to Musatova (2009); however, those results primarily focus on Russia, and we did not analyze preferences at country level.

Given greater cash flow predictability, shifting toward defensive industries in a shock seems plausible. Arundale and Mason (2020) showed investors shy away from the hardest-hit sectors, whether cyclical or defensive. Notably, transaction shares in cyclical industries increased consistently despite the shocks. This could imply that GPs had positive experiences investing in volatile industries during shocks, potentially at decreased valuations, providing significant returns in post-shock periods ("buy low, sell high"). Gompers et al. 2022) and Chen et al. (2021) observed increases in IT and healthcare investments during COVID-19, given that both industries benefited from COVID-19. In contrast to our findings, Gompers et al. (2022) show reduced investments in the energy industry, which should be put into perspective. Our results indicate that PE funds tend to shift capital to energy, also during COVID-19. However, sub-categories of energy (e.g., oil and gas) came under pressure, while others (e.g., renewables) show positive dynamics.

We note that GPs consistently prefer specific industries, implying that investors view them as safe harbors. Two industries consistently reduced shares across shocks, indicating they are perceived as unattractive.

GPs must evaluate their portfolio, fund timeline, risk preference, and strategy and adapt to the economic outlook. Shocks offer opportunities for GPs specialized in undesirable industries. Companies under financial stress seek financial support and accept generous terms. GPs must consider formats such as equity placements and flexible debt models. During shock phases, GPs with industrial specialization maintain their ability to select suitable targets for value creation. Reduced valuations provide opportunities to invest. Shifts in investment strategies require LP to adjust their risk preference and investment timeline (i.e., if a fund is due for repayment in the next year, investments in decreasing sectors are difficult to justify). However, extending the payout period by 2–3 years bridges short-term pressure and unlocks mid-term returns.

LP must re-assess their own risk preference, capital distribution timeline, and role, and they should evaluate involvement and support for GPs. Short-term capital distributions from funds with an industry footprint in sagging industries result in hits in profitability. However, LP should also remain critical toward the investments of GPs. They should evaluate the following: are GPs placing certain investments to capitalize on benefits potential (i.e., attractive investments in diminishing industries that they can identify based on their sector expertise), or are they following the general trends of perceived stable industries? Therefore, shocks require close collaboration between LP and GPs.

Ultimately, companies in the materials and technology hardware sectors requiring financing during a shock should target sources other than PE or accept increased premiums.

Identifying shocks early and acting faster than competitors in industry-driven investments can help GPs gain an edge. Comparing the decline in EBITDA-multiples to reductions in deal values shows that deal value decreases more (−31% vs. −11%), implying that investors prefer smaller transactions to diminish "clustering" risks.

This study has limitations. First, only buy-side transactions were analyzed, which limits the insights regarding holistic portfolio adaptations. Additionally, valuations at the industry level are not fully reflected. Furthermore, only three shocks are included in the study, limiting the general applicability of the results. Additionally, there are no insights into the success or failure of industry-based investment strategies due to a lack of data.

Conclusion

PE investing is sensitive to shocks; however, research mainly consists of anecdotal evidence. We analyze PE transactions during three shocks and identify energy, banks, insurance, and life science as sectors that constantly increase their share during shocks, implying that investors view them as safe harbors. In contrast, materials and technology hardware consistently reduced their share. Our conclusions are as follows:

Shocks create opportunities for GPs, particularly those specializing in materials and technology hardware. Short-term exits diminish, but so does competition. The ability to identify investments and to act swiftly is key. Capitalizing on these opportunities requires GPs to re-configure

their portfolio allocation, fund timeline, risk preference, and alignment with overall investment strategy. GPs with assets in energy, banking, insurance, and life science need to evaluate their exit strategy, given the short-term interest from financial investors.

For LPs, flexibility on investment horizon and capital distribution during a shock unlocks additional mid-term return opportunities, particularly when the GPs specialize in sagging industries. However, LPs should remain critical of generalist GPs and challenge capital over-allocation in perceived safe harbor industries.

Companies in the materials and technology hardware sectors seeking financing during a shock need to focus on sources other than PE or accept increased return expectations. Additionally, those companies are advised to target industry-specialized investors and shape their value proposition, concerning value creation potential.

Future research should analyze transactions at industry level in more depth, e.g., by taking valuations into account. Assessing the performance of industry-driven investment strategies during shocks by tracking profitability and returns for transactions would also be helpful.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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